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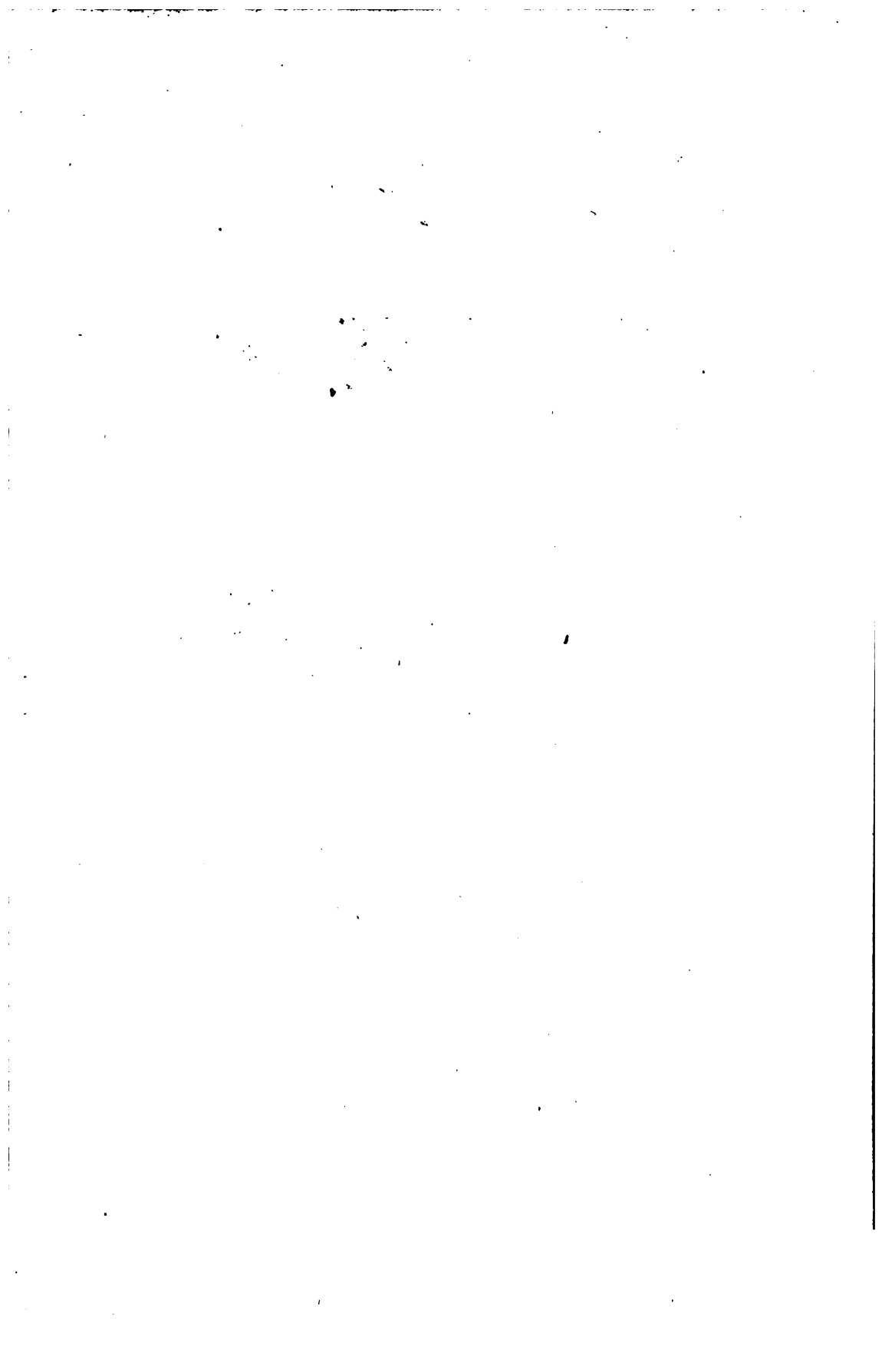
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A Survey of the Social and Business Usage of Arithmetic

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G. M. W.

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A SURVEY OF THE SOCIAL AND BUSINESS USAGE OF ARITHMETIC

I

THE PROBLEM

The problem set for solution in this study is to determine the arithmetic actually used by adults in their social and business relations. Such a determination should furnish useful data on which to base the school curriculum in arithmetic. The main assumptions of the study may be expressed briefly as follows:

(1) *Aim of Arithmetic in the Grades.* While not denying the cultural and disciplinary value of arithmetic—in common with any subject systematically studied and well taught,—it is assumed that arithmetic in the grades is justified only on the basis of its utility in the common affairs of life. We learn the multiplication table not to sharpen the wits nor to comprehend a beautiful system but to figure our bills, our taxes, or the interest on a note. Whatever arithmetic is given in the grades beyond the essentials required by social utility consumes time that could be used more profitably in other ways.

(2) *Determining the Social Utility of Arithmetic.* Social utility can be determined only on the basis of the uses of arithmetic in adult activities.

There are certain earlier studies which will help in understanding the present problem. Rice* in 1893 showed the need for better results in arithmetic, McMurry* in 1904 laid down principles for the selection of the subject-matter of the curriculum and gave them pointed application to arithmetic. Stone* in 1908 showed the wide variation in achievement in arithmetic and emphasized the need for better practice. The author and his teachers at Connersville* in 1911 issued a course of study in arithmetic that sought to eliminate the useless and the traditional and to provide motivated problems that would bring the

* See Bibliography.

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children into actual contact with business and life. Coffman and Jessup* later extended to city and county superintendents throughout the United States the Connersville plan of securing opinions on desirable eliminations and enrichments. The Minnesota Elimination Report* in 1914 and the Iowa Elimination Reports* in 1915 and 1916 sought to eliminate the traditional in arithmetic for entire states. The present study is a logical sequence of the author's interest in some of these studies, all of which, while helpful, are inconclusive. The question still remains in its original form: "What arithmetic is actually required by social and business usage?"

The study of present courses of study and time allotments has become common in recent years and has served a good purpose. Payne's* study in 1905 dealt with progressive cities and no doubt had much influence in cutting down the time allotment for arithmetic in less progressive towns and cities. Holmes,* in 1915, however, showed little change in time allotment for the cities involved in his study. A similar study was helpful to the makers of the Connersville course. Such studies are most useful when the reports upon them show total distributions rather than a few results statistically derived.

The application of statistical methods cannot solve the problem so long as present practice in arithmetic is chiefly determined by tradition. The refinements of statistical method are not sufficiently potent to get out of traditional subject-matter, courses of study, and text-books a precipitate which is essentially different from the original data. The attempts so far indicate that arithmetic needs the same kind of treatment as spelling received at the hands of Ayres and Jones, a treatment from the social point of view that shall make possible a selection of the functional materials of arithmetic, and the omission (as in spelling) of all that is merely traditional. The immediate result of such a study in spelling was to reduce the word list by 25 to 50 per cent, and at the same time secure a better functional product.

School men generally have recognized the desirability of determining the school curriculum on the basis of the demands of life outside the schools. The schools should give appreciation

* See Bibliography.

of life, lead to active and intelligent participation, and place in the child's hands the tools which will insure his success. It is recognized quite generally that arithmetic is one of the tool subjects and that its proper content can be determined only on the basis of an analysis of its use in business and in life. Many educators have referred to the desirability of such a determination, but have recognized its difficulties and the vast amount of time and labor involved. It is hoped that this study may not only meet these demands by charting the adult needs for arithmetic but also furnish a method by which the results may be extended and verified in different parts of the country. If it succeeds in laying a basis for constructive work in arithmetic comparable in a small measure with what Ayres and Jones have done for spelling, the study will have justified itself.

The assumptions of the present study are in common with previous studies. The method of procedure is entirely different. The present is not an elimination study, but a study to determine positively the desirable content of the course of study in arithmetic. The procedure is designed to find out what arithmetic mature people use, rather than what they do not use, except as that must follow perforce. The plan is to secure from mature people the actual figuring which they do, and then to analyze the problems thus secured in order to determine the actual social and business demands upon arithmetic. The plan of study should discover the processes used and the degree of difficulty of such processes. It may fail to discover adequately the interpretative values of arithmetic. It is quite probable, however, that arithmetical concepts and the interpretative values of arithmetic are by-products that are most fully realized through the use of arithmetic in actual business situations, and least realized when the work in arithmetic is artificial and mechanical.

It is realized that the validity of this study rests as much upon the method of securing the data as it does upon an analysis and interpretation of the data, and for that reason the sections immediately following explain in detail the method of gathering the data, the sources of the data, and the methods of scoring and evaluating the returns. The later sections show when arithmetic is used, the topics or the articles of trade, and the arithmetical processes involved.

II

METHOD OF GATHERING THE DATA

The data for this study consist of problems actually solved by mature people in the course of regular business. These were noted for each individual during a period of two weeks. The method of procedure was simple and its very simplicity is believed to be in large measure responsible for its success. The individuals chosen for report were the fathers and mothers of sixth, seventh, and eighth grade pupils in towns and cities of the Middle West. The work was undertaken only after the interest of the superintendents and teachers whose co-operation was necessary had been secured. The pupils of the chosen grades were then given instructions and provided with blanks on which to make a daily report of the problems actually solved by their parents.

A sheet containing the following instructions was sent to each superintendent and teacher assisting in the study:

ARITHMETIC SURVEY

The purpose of this study is to find out by a simple and direct method what mature people are figuring and to get some idea of the amount of figuring which they actually do. The material should be collected by sixth, seventh, and eighth grade pupils and this should be done in such a way as to interest these pupils in gathering the data. The following details should be observed:

Every father and mother of a sixth, seventh, or eighth grade pupil in your schools should be represented in the final returns. The effort should be made to get these data without particularly bothering or worrying the parents. In the evening, after the dishes are washed and the members of the family are together, the pupil should simply ask the mother (and father) whether or not she had any use for arithmetic during the day; if so, what? Then note the problems. They may relate to buying so many milk tickets for one dollar, to making change in connection with buying some eggs of a neighbor, or to figuring the bill from the grocer. In each case, the pupil should simply note the arithmetic involved and the statement should appear in simple problem form. No solutions are required. Where there is more than one child in the same family, the work should be divided. If the mother reports no use whatever and this continues for the two weeks, the report should be turned in just the same, giving the name of the person, the occupation and the dates covered.

It will doubtless be more satisfactory if the pupil will note on rough paper and then copy the problems the next day at school under the teacher's direction using the regular sheets which give the necessary general data at the top.

Please note that it is particularly desirable to get all of the data from every father and every mother, and not to get any extra data "trumped up" for the occasion. These directions should be followed and the pupils should be so thoroughly instructed that they will get into the game and get things right. If they see the purpose of the study, they will quite surely be interested. They will want to solve problems that actually come up for solution by mature people and they will want, also, to omit problems which do not have any practical value. Both of these are purposes in which the school is very greatly interested.

The blank on which the data were to be gathered, referred to in the above instructions, contained the following heading:

ARITHMETIC USED BY MATURE PEOPLE

Mr. or Mrs.....
Occupation
Problems figured during two weeks, following dates,.....
(List problems briefly; do not solve)

Many teachers had their pupils indicate the date for each day reported upon. This had the added value of checking more closely the work of the pupils. Many schools used uniform paper for making reports; while this was not essential, it added to the convenience in scoring. These added details are recommended in future applications of the study.

III

SOURCES OF THE DATA:

THE PEOPLE AND THEIR OCCUPATIONS

Having determined upon the study of the adult use of arithmetic, there remained the question of selecting the adults. From what social level should the adults be chosen? Should one attempt to reach a group of young adults, those who are in the initial stages of adult activity, possibly ranging in age from 18 to 25? Would it be better to select people of middle age, those who are in command of the more responsible positions, the leaders in social thought and action? The choice was finally made not upon *a priori* considerations of desirable groups or proper social levels, but upon the basis of availability. The fathers and mothers of sixth, seventh, and eighth grade pupils could be reached through interested sources and by those sufficiently intelligent to insure reliable returns. It now remains to turn about, analyze the returns, and determine how representative of society as a whole is the group chosen.

The group consists of fathers and mothers of upper grade children. It is safe to assume that the ages for the group fall largely between 35 and 45. These are the ages of earning, accumulation, leadership, and intense social activity. We may properly question, therefore, the advisability of making the use of arithmetic by this group the basis of our school work. Will it not be too difficult? The class is too highly selected. It contains no unmarried, no very young men or women. We will be thrown into the very midst of society's greatest business activity, and the child will be overwhelmed. These are proper doubts and deserve consideration. They can best be resolved by a study of the sources of the data under various heads, and later a complete analysis of the data.

From what parts of the country were the data collected? The answer to this question is contained in Table I. Column one of

the table shows town or city; column two, the population of the town or city; column three, the number of persons reporting; column four, the number of problems; and column five, the average number of problems per person.

TABLE I

SOURCE OF INFORMATION CONCERNING USE OF ARITHMETIC IN DAILY LIFE

City	Population 1915	Persons	Problems	Average Problems per Person
Van Cleve (Con.)†.....	75	11	35	3.2
Luther (Con.).....	141	24	37	1.5
Gillett Grove (Con.).....	150	12	17	1.4
Somers (Con.).....	178	45	174	3.9
Martelle (Con.).....	181	27	65	2.4
Westfield.....	198	4	122	30.5
New Providence (Con.).....	249	37	214	5.8
Meservey (Con.).....	257	15	45	3.
Grenville (Con.).....	400	13	24	1.8
Delhi.....	438	12	25	2.1
Terril (Con.).....	452	23	69	3.
Galva (Con.).....	478	19	85	4.5
Colo.....	536	47	435	9.3
Zearing.....	536	20	52	2.6
Jesup (Con.).....	789	73	243	3.3
Gladbrook.....	959	129	478	3.7
Tracy (Con.).....	1,378	36	57	1.6
Story City.....	1,576	42	180	4.3
Sigourney.....	2,009	25	85	3.4
Marshalltown.....	16,065	735	3,092	4.2
Topeka, Kans. (1910).....	43,684	1,494	5,621	3.8
Sioux City.....	61,774	837	1,978	2.4
Duluth, Minn. (1910)....	78,466	259	1,186	4.6
Iowa, Parts of.....		129	264	2.0
Totals		4,068	14,583	3.64

† (Con.) means consolidated.

In gathering these data, an effort was made to reach representative groups. The country, the small town and the large city are all represented. The towns are in Iowa unless otherwise indicated. The problems gathered from parts of Iowa were sent in by teachers from rural schools. The indication (Con.), following a number of towns, means a consolidated school. Many of these schools are based upon a population largely rural. Practically all of them, however, are located in small towns and there are other small towns in the list. The larger cities are represented by Marshalltown and Sioux City (Iowa), Topeka (Kansas), and Duluth (Minnesota). Sioux City

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is a commercial center. Topeka is representative of the larger cities in the Middle West with little manufacturing, and Duluth is a manufacturing and commercial center. It is evident, therefore, that the population represented in the above is typical of all classes of people in the Middle West.

How fully are the various occupations represented by the people making returns? Table II gives a distribution of the people by occupations, and shows also the number of problems reported from each occupational group. There is a total of 14,583 problems from 4,068 persons. The persons are distributed among 155 specific occupations. For purposes of reference the list is arranged alphabetically according to the common or most likely designation. In beginning the study it was realized that the Middle West was fairly representative of the nation as a whole, and an effort was made to secure returns in such proportions from rural districts, consolidated districts, town and city systems, as to have the people divided by occupations somewhat in proportion to the total population. On this basis it was figured that half the returns should be from women, and this apparently has been accomplished, 1,996 housekeepers alone reporting, or 49 per cent of the total. Housekeeping is the normal occupation of well-to-do adult women. Because of the fact that it is a non-wage-earning occupation it does not appear in the census returns on occupations, and so is given special mention at this point.

TABLE II
SHOWING THE OCCUPATIONS REPRESENTED IN THE STUDY WITH PERSONS
AND PROBLEMS UNDER EACH

Occupations	Per- sons	Prob- lems	Occupations	Per- sons	Prob- lems
1. Abstractors....	2	2	13. Basket makers.	1	2
2. Actors.....	1	4	14. Blacksmiths....	14	54
3. Advertising managers....	2	3	15. Boiler makers.	3	18
4. Anti-Saloon League supt.	1	1	16. Bookkeepers....	41	114
5. Architects.....	2	3	17. Brass workers..	1	5
6. Auctioneers....	5	16	18. Brick dealers...	3	1
7. Auditors.....	1	16	19. Bridge workers.	10	33
8. Auto dealers...	2	10	20. Brokers.....	2	6
9. Auto men.....	5	19	21. Butchers.....	19	60
10. Bakers.....	9	34	22. Butter makers.	3	11
11. Bankers.....	20	49	23. Cafe workers...	6	34
12. Barbers.....	14	47	24. Carpenters	114	381
			25. Cashiers.....	5	34
			26. Cement men...	1	7

Sources of the Data

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TABLE II—(Continued)

Occupations	Per- sons	Prob- lems	Occupations	Per- sons	Prob- lems
27. Chambermaids.	1	9	72. Implement deal- ers.....	8	44
28. Cigar manufac- turers.....	1	3	73. Insurance agents.....	19	58
29. Cleaners.....	2	8	74. Iron workers...	2	14
30. Clerks.....	33	93	75. Janitors.....	9	32
31. Coal dealers...	7	26	76. Jewelers.....	5	11
32. Coal miners...	1	5	77. Junk dealers...	2	29
33. Confectioners...	1	1	78. Laborers.....	120	444
34. Contractors...	36	104	79. Landlords.....	1	10
35. Cooks.....	1	2	80. Laundrymen...	2	12
36. Crate makers...	1	3	81. Lawyers.....	16	57
37. Creamery work- ers.....	2	7	82. Liquor dealers.	1	1
38. Dairymen.....	1	1	83. Liverymen....	5	23
39. Dance hall managers....	1	1	84. Lumbermen...	14	40
40. Decorators.....	3	7	85. Machine repair- ers.....	5	12
41. Ditchers.....	3	13	86. Mail carriers...	10	72
42. Doctors.....	26	107	87. Masons, brick and stone...	33	95
43. Draymen.....	3	10	88. Manufacturers..	9	16
44. Dressmakers...	8	40	89. Material mark- ers.....	1	20
45. Druggists.....	9	26	90. Mattress mak- ers.....	2	6
46. Editors.....	1	5	91. Mechanics.....	88	330
47. Electricians....	12	50	92. Merchants.....	168	550
48. Employment agents.....	1	1	93. Millers.....	11	62
49. Engineers.....	26	107	94. Ministers.....	19	42
50. Excavators.....	1	7	95. Motormen.....	3	38
51. Express mes- sengers.....	1	2	96. Moulders.....	8	40
52. Factory Supts.	3	11	97. Musicians.....	3	10
53. Farmers.....	298	1,077	98. No occupation given.....	93	205
54. Feed yard man- agers.....	1	3	99. Nurses.....	4	14
55. Firemen.....	9	59	100. Operators.....	2	8
56. Florists.....	3	9	101. Painters and paper hang- ers.....	31	121
57. Foremen.....	51	165	102. Peddlers.....	7	8
58. Fruit dealers...	4	35	103. Photographers..	4	11
59. Furniture deal- ers.....	3	36	104. Piano dealers..	1	3
60. Garage man- agers.....	4	11	105. Picture show managers....	2	2
61. Gardeners.....	1	9	106. Plumbers.....	7	17
62. Grain dealers...	9	29	107. Plasterers.....	4	8
63. Grocers.....	18	94	108. Policemen.....	10	78
64. Gunners.....	1	4	109. Post office em- ployees.....	8	25
65. Hardwaremen and tanners.	19	112	110. Postmasters....	1	3
66. Harness makers	6	48	111. Poultry dealers.	1	2
67. Horse buyers...	3	6	112. Printers.....	25	80
68. Hotel keepers...	12	86	113. Produce dealers	1	2
69. Housekeepers... 1,996	7,345		114. Purchasing agents.....	1	1
70. Ice cream mak- ers.....	1	10			
71. Icemen.....	1	4			

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TABLE II—(Concluded)

Occupations	Per- sons	Prob- lems	Occupations	Per- sons	Prob- lems
115. Railway brake- men.....	3	3	135. State house clerks.....	1	2
116. Railway em- ployees.....	113	385	136. Stock dealers..	14	36
117. Railway engi- neers.....	1	1	137. Stock yard em- ployees.....	16	19
118. Railway freight agents.....	1	1	138. Stone (cut) con- tractors.....	1	1
119. Railway section hands.....	3	4	139. Switchmen.....	4	19
120. Railway ticket agents.....	6	39	140. Tailors.....	3	5
121. Real estate agents.....	50	82	141. Taxi drivers...	2	5
122. Restaurant managers....	2	8	142. Teamsters.....	34	170
123. Retired business men.....	1	1	143. Telephone man- agers.....	1	1
124. Sailors.....	1	1	144. Telepho n e. operators....	6	15
125. Salesmen.....	69	197	145. Theater man- agers.....	1	9
126. Saloon keepers.	1	10	146. Time keepers..	2	2
127. Salvage corps captains....	1	1	147. Truck drivers..	2	4
128. Sand haulers...	1	3	148. Undertakers....	1	4
129. School teachers	8	14	149. Washwomen....	2	5
130. Sheriffs.....	1	7	150. Watchmen.....	3	16
131. Shoemakers....	1	1	151. Water meter in- spectors.....	2	9
132. Shoe merchants	6	31	152. Wax figure ar- tists.....	1	3
133. Silo builders...	1	3	153. Well diggers....	2	7
134. Skating rink managers....	1	10	154. Wholesale deal- ers.....	16	32
			155. Wood workers..	5	6
				4,068	14,583

Dr. Ayres made a brief study* of constant and variable wage-earning occupations in the cities of the United States of 50,000 or more population. The study was based upon the Twelfth Census (Census of 1900), and showed a total of 68 occupations coming under his definitions in the 78 cities of the United States as follows:

Constant occupations (1 in each 1,000)	}	men.....	20
		women.....	7
Variable occupations (1 in each 10,000)	}	men.....	31
		women.....	10
		Total.....	68

How many of these 68 wage-earning occupations are represented in the present study? Careful checking shows that 62

* See Bibliography.

of them are represented, the 6 unrepresented occupations being waiters, servants, hucksters, tinplate workers, hostlers, upholsterers. It is possible that some of these six occupations are covered under the general heads of Table II. For example, a few women who report themselves as housekeepers are keeping house for others, i.e., they are servants; but this is a class carrying social stigma and they did not want to be so designated. There are quite surely among the café and restaurant workers reported, some who are waiters. There is a possibility also that some of the men working in factories and shops may be doing upholstery work. However, if it is agreed that six of Ayres' lists do not appear in this study, it still appears that the study is quite representative of large city occupations; in fact, it covers the list more fully than expected since only three cities with a population of over 50,000 each were included.

The Thirteenth Census (1910) gives particular attention to occupational studies and will furnish the best single source for checking the representative character of the occupations included in this study. The volume on occupations of the Thirteenth Census contains a table (Table 14, p. 53, vol. 4) giving the principal occupations for all persons ten years of age and over engaged in gainful pursuits. This table lists 101 fundamental occupations, under nine groups. The proportion of people in each of these groups, with the same data from Iowa, and for this study, is shown in Table III which follows:

TABLE III
DIVISION OF WORKERS AMONG THE MAIN OCCUPATIONAL LINES IN THE
UNITED STATES AS A WHOLE, IN IOWA, AND IN THIS STUDY

Class	U. S.	Iowa	This Study
1. Agriculture, forestry, and animal husbandry..	33.2%	42.9%	16.2%
2. Extraction of minerals	2.5	1.9	.1
3. Manufacturing and mechanical industries....	27.9	19.1	30.9
4. Transportation.....	6.9	7.9	15.3
5. Trade.....	9.5	10.3	25.9
6. Public service (not elsewhere classified).....	1.2	.9	1.4
7. Professional service.....	4.4	6.2	4.8
8. Domestic and personal service.....	9.9	7.8	2.9
9. Clerical occupations.....	4.6	3.1	2.5
Total.....	100.0	100.0	100.0

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Table III shows that the nine fundamental divisions of industry are very nearly in the same proportions for the United States and for Iowa. Iowa is above in (1) agriculture, (4) transportation, (5) trade and (7) professional service; and a little below in each of the other lines. The parallel is close enough to indicate that Iowa and the Middle West are fairly representative of the entire country industrially. The specific occupations of the entire United States as they appear in the Thirteenth Census (Table 2, pp. 110-122, vol. 4) number 429, 403 of which appear in Iowa.

The last column of Table III is secured by dividing the occupations of Table II among the nine basic divisions of the Thirteenth Census, and then figuring percentages. However, the base for figuring percentages is 1,979 instead of 4,068, since housekeepers (1,996) and no occupations (93) are omitted from the consideration. The wide departures in column three from the situation in Iowa or the United States are found upon examination to be desirable for purposes of this study. The decreases under items 8 and 9 are to be expected, since mature married people are not engaged in large numbers in domestic and personal service or clerical occupations. The figure for item 7, professional service, is practically the same as for the United States as a whole. The increases under items 3, 4, and 5 are desirable because of the large number of specific occupations represented under these items. It appears that the people engaged in manufacturing, mechanical industries, transportation, and trade were ready in their coöperation, indicating intelligent understanding and appreciation of the work of the schools. That these lines are slightly larger in proportion seems acceptable also because these are the lines that are ordinarily thought of as best representing business and industry, for which the arithmetic of the schools is designed to prepare children. On the other hand, the decrease in proportion of farmers, item 1, is no particular disadvantage, since the total number, 298,* is sufficient for the study, and farming in the Middle West is not a highly diversified occupation in the sense that "manufacturing and mechanical industries" is a diversified occupational field. While

* See item 53 of Table II.

the number of farmers is low in proportion, it is sufficient to give a good list of representative problems.

The specific occupations of Table 14, p. 53, vol. 4, of the Thirteenth Census were analyzed to see how fully they were represented in this study. The nine fundamental lines contain a total of 101 groups of occupations as follows:

1. Agriculture, forestry, and animal husbandry.....	10 groups
2. Extraction of minerals.....	4 "
3. Manufacturing and mechanical industries.....	25 "
4. Transportation	16 "
5. Trade	11 "
6. Public service (not elsewhere classified).....	6 "
7. Professional service	9 "
8. Domestic and personal service.....	16 "
9. Clerical occupations	4 "
	101

There are in the table 25 additional heads, such as "all others in this division," "apprentices," "laborers" or "semi-skilled operators," that repeat other items. These are not considered for the reason that people in reporting themselves, as in the present study, do not indicate their scale of proficiency or advancement. They merely report the industry unless the position is an advanced one such as foreman, manager, or superintendent.

Taking 101 as the number of specific occupations or occupational groups in the Thirteenth Census, how many of them are represented in the present study? The answer is 93. The eight groups not known to be represented are:

1. Artists, sculptors, teachers of art
2. Dairy laborers
3. Deliverymen
4. Gold and silver operatives
5. Hostlers and stable hands
6. Messenger and office boys
7. Sewers and sewing machine operators (factory)
8. Waiters

It is possible that some of these occupations are covered by general or similar terms in Table II. Dairy laborers may have reported themselves as farmers, stable hands may have reported themselves as liverymen, waiters may be included under another term as previously indicated. Some of these occupations are scarce and some are juvenile, so it is quite certain that some of

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them are not represented among the class of mature married people forming the basis of this study.

A word may be added as to the more or less unscientific character of the classification of occupations as they appear in Table II. The desirability of a careful classification of the occupations represented was considered early in the study. It was permitted to take its course unchecked by any formal scheme because of (1) the difficulties involved, and the extra labor and inconvenience placed upon coöperating teachers and superintendents; (2) the realization that the final returns would not be made much more reliable, since the coöperation of children was necessarily involved if large numbers of returns were to be secured; and (3) the evident fact that the validity of the study would not be impaired on account of the absence of a plan of checking occupations similar to or comparable with the census classification.

As a result of the plan used, some classes of occupations are known to be quite extended in range. Notice a few illustrations:

1. Veterinarians are included under doctors.
2. Boarding-housekeepers are included under hotel keepers.
3. The term "salesmen" covers salesmen, city salesmen, traveling salesmen.
4. Many are reported as merchants, without specifying the line. In tabulating, further use was made of the term "merchants," and it is known to cover milliners, department store operators, butchers, grocers, and others.
5. Railway employee is known to cover the following: box car repairman, cashier, car carpenter, car inspector, chief clerk, conductor (freight and passenger), division freight agent, locomotive fireman, passenger agent, railway statistician, street railway conductor, street railway motorman, steward, store house manager, switchman, telegraph operator, train auditor.
6. Laborer doubtless covers many other specific lines in addition to the following which appeared in a brief checking:
Boiler maker, box maker, bridge gang worker, city employee, cabinet maker, caterer, chauffeur, excavator, foundry worker, gasfitter, gunner, house cleaner, lumberman, mill engineer, oil driller, state house workman, steamfitter.

In conclusion it must be apparent that the study is reasonably representative. It is based upon a section of the United States which may be taken as representing the entire country about as well as any section that could be chosen. The fundamental occupational groups are represented on a satisfactory basis. The specific occupations are well represented and those

not appearing are less typical of business and industry in general. Under the circumstances, it is believed that the problems gathered show quite faithfully a cross section of the social and business usage of arithmetic.

No one who will take time to examine the data can doubt their validity. They were gathered through the honest and earnest coöperation of parents, pupils, teachers, and superintendents. There is no better foundation upon which to base the gathering of data. Opinions were not asked, only a simple report of facts. What figuring did you do to-day? That was the question. The problems were to be noted only, not solved. There could be no motive for obscuring or changing the facts.

The internal evidence that the data were faithfully gathered is seen in the changing nature of the problems as they came in at different seasons of the year. Practically the entire year was taken in securing the problems. As one superintendent after another expressed an interest, detailed instructions were sent to him and he proceeded to organize his teachers for the work. Some superintendents did this early in the fall; others, not until near the close of the school year. The seasonal character of the problems corresponds to the dates upon the papers. Taxes were being paid only at tax-paying time. In December, it was more and more apparent that Christmas was approaching. In the spring vegetables were bought, screens provided, etc. The fact that the problems showed this seasonal character so strongly is an indication that the work was faithfully done and that the returns correctly represent actual social and business usage.

IV

METHOD OF SCORING AND EVALUATING THE RETURNS

The amount of work involved in this study made it impossible for one person working alone to do it within a reasonable time. In order to secure uniformity of results therefore, definite directions for scoring the problems were written out and then explained carefully to each person helping with the work. It was possible also for the author to work with each person long enough to make sure that the ideas were uniform. The following printed directions were used.

DIRECTIONS FOR SCORING

Each problem should be studied and scored on the following points:

1. Cross out any problem that appears to be made up for the occasion. Only real problems should be scored.
2. Buying or selling.
3. United States money involved and the number of places involved in the factors of the problem.
4. Topic or article bought or sold (or involved).
5. Arithmetical processes, as addition, subtraction, etc.
 - a. In addition, subtraction, multiplication, and division, the degree of difficulty is to be noted as one place, two places, three places, etc. In addition and subtraction this means the addends or the terms involved and not the answers. In multiplication the multiplier is to be considered, in division the divisor.
 - b. In fractions, every fraction appearing is to be scored. The list will be sufficiently short.
 - c. Other processes are to be scored without noting the degree of difficulty.

The instructions were written in the order indicated above after it became apparent to the author that the points could be seen most quickly in that order. As soon as a scorer began to read a problem, he could begin to write in the margin either "buying" or "selling." Directly, he could indicate United States money and the number of places involved. The topic would be apparent by this time, leaving only at the conclusion

of the reading of the problem the final item, process and degree of difficulty. Item 5, under directions for scoring, shows detailed instructions as given for the various processes. The first five thousand fractions were scored on the basis of a general scheme. By that time it became apparent that all fractions could be listed. Instructions were changed accordingly and the fractions in the first five thousand problems were re-scored.

The reason that the instructions for scoring needed modification in but a single item, was due to the fact that considerable preliminary scoring was done before the instructions were written. At the conclusion of the entire work there was a feeling of satisfaction with the instructions and with the scoring. It was evident that the plan had been sufficiently complete to analyze the situation and sufficiently definite to justify comparisons and conclusions. No one was permitted to participate in the work who was not at least a junior in college and interested in education in general and the work in hand in particular. As a result there was little monotony; there was keen interest and reasonable enjoyment throughout the entire work. Some students went considerably further with their particular work, drawing off conclusions with reference to particular occupations and making up lists of problems for them. These were not turned in as a part of the work and the final list of typical problems was made up by the author alone in order to insure completeness and uniformity.

Although the directions were quite specific and the actual work of scoring preceded by preliminary drill, difficulties were constantly arising in handling particular papers. These and the detailed work of scoring will be more apparent through the examination of typical papers.

PAPER NO. 247—MARSHALLTOWN

THE PAPER

THE SCORING

*Name:—*Mr. and Mrs. J. M. C.

*Occupation:—*Carpenter

*Problems figured during two weeks:—*Dec. 8 to Dec. 21
(*List problems briefly; do not solve*)

1. What will be the cost of 5 yds. of crepe de chine at \$1.75 a yard?

Buying
*U. S. M.—*3 p.
Dry Goods
*Mult.—*1 p.

H

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THE PAPER

2. In Christmas shopping to-day, I bought a razor at \$1.50, a belt and belt buckle at \$3.50, and a wrist watch at \$25. What was the total?

H

3. Find the cost of meat at .35, bread .10, cookies .15, and a can of pork and beans at .15.

H

4. Find the cost of material \$150 and men's labor \$75.

THE SCORING

Buying
U. S. M.—3 p, 4 p.
Miscellaneous
Add.—4 p.

Buying
U. S. M.—2 p,
Groceries
Add.—2 p.

Buying
U. S. M.—4 p, 5 p.
Materials and labor
Add.—3 p.

PAPER No. 248—MARSHALLTOWN

THE PAPER

Name: Mr. and Mrs. J. G. H.

Occupation: Carpenter

Problems figured during two weeks: Dec. 8-21, 1916.

(List problems briefly; do not solve)

1. Dec. 8, 1916.

Bought 8 lbs. of meat at 16c a lb. How much did it cost?

H

2. Dec. 11, 1916.

Father bought a chisel for 55c and 2 lbs. of lard compound at 16c a lb. What was the total cost?

3. Dec. 12 1916.

Bought 2 sacks of flour at \$2.25 a sack. How much did it cost, and how much change from a five dollar bill?

4. Dec. 13, 1916.

No arithmetic used.

5. Dec. 14, 1916.

Bought 2 lbs. of oleomargarine at 30c a lb. What did it cost?

H

6. Dec. 15, 1916.

Father bought 2 tons of coal at \$5.25 a ton. How much did it cost?

7. Dec. 18-20, 1916.

No arithmetic used.

THE SCORING

Buying
U. S. M.—2 p.
Meat
Mult.—1 p.

Buying
U. S. M.—2 p.
Tools, etc.
Mult.—1 p.
Add.—2 p.

Buying
U. S. M.—3 p.
Flour (groceries)
Mult.—1 p.
Subt.—3 p.

Buying
U. S. M.—2 p.
Groceries
Mult.—1 p.

Buying
U. S. M.—3 p.
Coal
Mult.—1 p.

THE PAPER

8. Dec. 21, 1916.
Bought 6 boxes of matches for 25c. Gave clerk
a 25c piece.

H

THE SCORING

Buying?
U. S. M.—2 p.
Groceries

PAPER No. 510—MARSHALLTOWN

THE PAPER

Name: Mr. and Mrs. H. E. W.
Occupation: Farmer and dairyman
Problems figured during two weeks: Dec. 8-20, 1916.
(List problems briefly; do not solve)

THE SCORING

1. A farmer takes 23 gal. of milk at 20c per gal.
What is the total cost?

Selling
U. S. M.—2 p.
Milk
Mult.—2 p

2. A woman bought 5 1/3 yds. of silk at \$1.10 a yd.
What is the total cost?

H

Buying
U. S. M.—3 p.
Dry Goods
Mult.—1 p.
Fract.—1/3

3. A woman bought syrup at 60c, breakfast food at
25c, oysters 50c, and crackers at 15c. What is
the total cost?

H

Buying?
U. S. M.—2 p.
Groceries
Add.—2 p.

4. A farmer sells 21 gal. of milk at 20c a gal. and 10
gal. at 18¢ per gal. What is the total cost?

Selling
U. S. M.—2 p.
Milk
Mult.—2 p.
Add.—3 p.

5. If a woman buys two toys at 10c each, a toy
lantern for 15c, a fur cap for \$5, and a pair of
mittens for \$1.10. How much change shall be
received from a ten dollar bill?

H

Buying
U. S. M.—2 p, 3 p.
Miscellaneous
Add.—3 p.
Subt.—4 p.

6. If a woman buys meat at 25c, cookies at 20c and
candy at 10c. What is the total cost?

H

Buying
U. S. M.—2 p.
Meat and Groceries
Add.—2 p.

The following are difficulties encountered in scoring, which
are illustrated in the above sample papers:

1. The problems of father and mother were seldom reported
separately. It was necessary, in order to avoid confusion and
misrepresentation, to indicate the problems belonging to each,
and this was done by marking with an "H" (meaning house-

keeper) all problems belonging to the mother. The problems so marked were collected and tabled under housekeepers, leaving the others to be tabled under the occupations of the fathers.

2. The difficulty of indicating the topic or articles involved in Christmas shopping first led to the use of "miscellaneous" for this purpose. This is illustrated in problem 2, paper 247—Marshalltown. Occasionally department store purchases are so listed. In spite of the instruction to list nothing under "miscellaneous" that could be classified elsewhere, the total scores under this caption reached 630.

3. Problem 4 of paper 247—Marshalltown, shows dollars without any cents being involved. The scorings under "U. S. Money" are 4 place and 5 place, but under "addition" only 3 place. Since it is unnecessary to express the cents, it is manifestly an addition problem of only 3 places,— $\$150 + \$75$. The scoring for "U. S. Money" is therefore two places too high. This is a common error, as explained elsewhere.

4. Problem 8 of paper 248—Marshalltown, shows a situation where business is transacted, but no computation required. Such a problem requires no score under processes. Problems 2 and 3 of this same paper show double scores for processes. Irregularities of this kind make it impossible to balance total problems against a total of all processes.

These typical papers, as scored and commented upon, should make clear any ambiguities in the directions for gathering the data, or scoring and evaluating the returns.

The instructions required that only real problems be scored. In order to determine how fully the spirit of the work was understood, a careful study was made of the problems thrown out. One cannot help being impressed that the work was taken seriously and performed in the spirit of honest coöperation. There is an occasional problem (estimated at about 1 in 1,000) which is apparently a "made up" problem; at any rate no motive was apparent to the scorer and it was thrown out. The following is an illustration: If a stream flows at the rate of 10 yards in 1 minute, how long will it take it to go 5 miles?" One can conceive a situation where the above might be a real problem, but no such situation is apparent in the report.

The most common cause for throwing out problems was that

the facts given were not sufficient to permit a solution, or were too simple to require a solution. The following are illustrations:

1. The cost of two flower boxes including the dirt and flowers.
2. My mother had to add up the grocery bill to see how much was required to pay it each week.
3. Mamma wanted to get me a dress. She knew how much a yard would cost and she had to figure out how much $4\frac{1}{2}$ yards would cost.
4. If I pay ten dollars a month for board and room, five dollars for clothing and five for amusements, putting the rest in the bank, how much do I put in the bank?
5. My mother wants to buy a peck of potatoes. They are 28c a peck. How much will she have to pay?

The "thrown outs" from the Topeka returns may be taken as illustrative of the numbers thrown out. The following is the summary:

Papers thrown out.....	82
Additional problems marked out of papers left in...	113

The papers were thrown out chiefly because the occupations were not reported. The individual problems thrown out contained insufficient data and are well illustrated by the "thrown out" problems given above. Throwing out papers and problems not usable was one of the important tasks of the scorer, and in the later scoring this and the separation of papers according to occupations were the first things done.

V

WHEN IS ARITHMETIC USED?

Reference to Table I shows that the 4,068 persons during a period of two weeks reported a total of 14,583 problems, or an average of 3.64 problems per person. This may be lower than the number of problems actually used because of failure to report; or it may be higher because, under pressure from the children, the father and mother were putting work into problems which was permitted ordinarily to go unfigured. Careful study and checking of the data indicate that the returns may be taken as representative of the amount of figuring done by the average mature citizen.

The returns from Mondamin, Iowa, were gathered in a little different form. For that reason they are not included in the tabulations of this study, but they furnish help in answering the question proposed for this section. The three papers which follow (from Mr. and Mrs. S. G. M., Mr. and Mrs. P. Y., and Mr. and Mrs. M. J. W.) are typical.

Name: Mr. and Mrs. S. G. M.

Occupation: Farmer

Jan. 25th—Made out a check

Jan. 26th—No business

Jan. 27th— " "

Jan. 28th— " "

Jan. 29th—Made out check

Jan. 30th—No business

Jan. 31st— " "

Feb. 1st— " "

Feb. 2nd—Bought some groceries, hardware, shoes fixed

Feb. 3rd—Sent off money order

Feb. 4th—No business

Feb. 5th—Separator fixed

Feb. 6th—No business

Feb. 7th— " "

Name: Mr. and Mrs. P. Y.

Occupation: Farmer

Jan. 29, 1917—Did no business to-day

Jan. 31, 1917— " " "

Feb. 1, 1917—Bought five cents worth of pencils
Feb. 2, 1917—No business
Feb. 3, 1917—Bought one tablet at 5c
Feb. 4, 1917—Sunday
Feb. 5, 1917—Bought two loads of cobs
Feb. 6, 1917—Sold corn
Feb. 7, 1917—No business
Feb. 8, 1917— “ “

Name: Mr. and Mrs. M. J. W.

Occupation: Farmer

Jan. 29—No business
Jan. 31—Sold apples
Feb. 1—Bought coal
Feb. 2—Sold a calf
Feb. 3—Bought groceries
Feb. 4—No business
Feb. 5—Sold butter
Feb. 6—No business
Feb. 7— “ “
Feb. 8—Paid hired man
Feb. 9—Sold butter—Bought groceries
Feb. 10—No business
Feb. 12— “ “

These papers, it will be observed, report not on “figuring done” but on “business transacted.” It appears that Mr. and Mrs. S. G. M. transacted business on 5 days out of the 14 reported upon; Mr. and Mrs. P. Y. transacted some business 4 days out of 11; and Mr. and Mrs. M. J. W., 6 days out of 15. Some of the transactions are small, and they are about equally divided between father and mother. A distribution of the returns from Mondamin shows a range in number of days on which business was done in two weeks, from 2 days to 14 days, the latter instance being a man who was a stock buyer and real estate agent as well as a farmer. The median is 7 days out of two weeks. But the number of papers from Mondamin is small and reference is made to the data chiefly because they are definitely dated in each paper and serve well for illustrative purposes.

The following are three representative papers from Marshalltown (Nos. 36, 256, 521), from a farmer, carpenter, and housewife respectively. The number of problems for the two weeks are 3, 6, and 4. The problems in paper 521 are scored as the mother's problems, her husband being a salesman. Apparently no problems were reported for him. The papers contain about the average number of problems of about the average difficulty.

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They emphasize the impression that figuring is done only when business is transacted.

PAPER No. 521—MARSHALLTOWN

Name: Mr. and Mrs. M. H. P.

Occupation: Salesman

Problems figured during two weeks: Dec. 8 to Dec. 22

(*List problems briefly; do not solve*)

Dec. 9, 1916—You get 14 milk tickets for \$1.00, what will one cost?

Dec. 10, 1916—No arithmetic used.

Dec. 11, 1916— " " "

Dec. 12, 1916— " " "

Dec. 13, 1916— " " "

Dec. 14, 1916— " " "

Dec. 15, 1916—Paid the dealer \$.50 for some sugar and gave him \$1.00.
How much received back?

Dec. 16, 1916—No arithmetic used

Dec. 17, 1916— " " "

Dec. 18, 1916—Cloth cost 7c a yard. What will four yards cost?

Dec. 19, 1916—No arithmetic used

Dec. 20, 1916—Bought some Christmas cards at 5c a piece and bought
9 cards and paid the dealer \$1.00. How much received
back?

Dec. 21, 1916—No arithmetic used

Dec. 22, 1916— " " "

PAPER No. 256—MARSHALLTOWN

Name: Mr. V. C.

Occupation: Carpenter

Problems figured during two weeks: Dec. 7 to Dec. 21.

(*List problems briefly; do not solve*)

Dec. 7—I was to pay \$2.15 light bill. I gave the clerk \$5.00. How much
did I get back?

Dec. 8—Men did work for \$5.75 for today. Other day's work was
\$3.50. How much do I owe them?

Dec. 9—Man owed me \$8.75. Paid me \$5.25. How much more does
he owe me?

Dec. 10—No arithmetic used

Dec. 11— " " "

Dec. 12— " " "

Dec. 13—Bought some lumber which amounted to \$113.29. I paid \$96.75
on the bill. How much more do I still owe him?

Dec. 14—No arithmetic used

Dec. 15— " " "

Dec. 16— " " "

Dec. 17—Paid \$8.75 for some lumber, \$10.23 for some shingles. What
does the bill amount to?

Dec. 18—No arithmetic used

Dec. 19— " " "

Dec. 20—Bought 2 pairs of overalls for \$4.25, one pair of shoes for \$4.50.
What does the bill amount to?

Dec. 21—No arithmetic used

PAPER No. 36—MARSHALLTOWN

Name: Mr. and Mrs. E. L. M.

Occupation: Farmer

Problems figured during two weeks: Dec. 7 to Dec. 21

(List problems briefly; do not solve)

Dec. 7, 1916—Bought coffee \$1.00—milk \$1.00

Dec. 11, 1916—No arithmetic used

Dec. 12, 1916— " " "

Dec. 13, 1916— " " "

Dec. 14, 1916—Bought meat 50c, syrup 25c, quinine 50c, matches 5c, and yeast, 5c.

Dec. 15, 1916—Meat 25c, oranges 5c, kraut 50c, crackers 10c, meat 60c, apricots 25c, peaches 25c, crackers 5c, oil 15c, cinnamon rolls 10c, mixed candy 15c, 1 qt. of cranberries 10c, potatoes 50c, beans 50c, rice 19c, oat meal 10c, sugar \$1.00, lemons 5c, candy 25c, sweet potatoes 25c, flour \$5.30, candy 10c, oil 60c, corn meal 35c, meat 50c, peroxide 10c, car fare 50c, yeast 10c, soap 15c, toilet soap 10c, tablets 10c, oranges 5c, syrup 10c, meat 50c, milk \$1.00, coffee \$1.00, vinegar 5c, ginger 5c, tobacco 45c. Total for groceries for the two weeks amounted to \$15.66.

Dec. 16, 1916—No arithmetic used

Dec. 19, 1916— " " "

Dec. 20, 1916— " " "

Dec. 21, 1916—Syrup 20c, beans 25c, hunting license \$1.00, brown sugar 10c. How much spent?

Reference to Table I shows an average of 30.5 problems per person reporting from Westfield. The papers have been carefully examined, and since they show evidence of bona fide problems they are included. It seems that only the few papers were returned which showed many problems. These papers are from a hotel keeper and three farmers and contain 33, 32, 32, and 25 problems respectively. The hotel keeper had many small transactions each day, as he bought canned goods, meat, groceries, etc., and the same is largely true of the farmers' transactions. It appears that corn was being harvested, that several hired hands were being fed, and that daily trips to town followed.

Considerable evidence that arithmetic is used little except in business transactions is contained in Table IV which shows the occurrence of buying and selling and the presence or absence of money in problems not involving buying or selling. The table shows in Van Cleve, for instance, that 19 of the problems involved buying, 12 of them selling, and 9 involved money without buying or selling.

TABLE IV
BUYING AND SELLING

Places	Total Problems	Buying	Selling	Neither Buying nor Selling	
				Money	No Money
Van Cleve.....	35	19	12	9	
Luther.....	37	21	16		1
Gillett Grove.....	17	4	12	2	1
Somers.....	174	81	47	8	48
Martelle.....	65	137	18	5	1
Westfield.....	122	84	39		
New Providence.....	214	136	57		5
Meservey.....	45	22	8	4	8
Greenville.....	24	5	13		6
Delhi.....	25	13	8	2	2
Terril.....	69	40	13	16	6
Galva.....	85	20	19	3	2
Colo.....	435	295	115	16	10
Zearing.....	52	34	14	2	3
Jesup.....	243	192	42	13	4
Gladbrook.....	478	268	108	58	54
Tracy.....	57	34	30		3
Story City.....	180	75	37	43	19
Sigourney.....	85	65	13	1	8
Marshalltown.....	3,092	2,223	197	317	204
Topeka.....	5,621	3,429	254	457	183
Sioux City.....	1,978	1,610	193	287	92
Duluth.....	1,186	918	118	178	83
All parts of Iowa.....	264	79	117	20	38
Totals.....	14,583	9,804	1,500	1,441	781

Of the total of 14,583 problems, 9,804 involved buying, 1,500 involved selling, and 1,441 involved money where there was neither buying nor selling. This means that money is involved in 12,345 problems or 83 per cent of all problems. It should be noted that Table IV does not check exactly; that is, the total of problems involving buying and selling added to those not involving buying and selling does not give a sum equal to the total problems. This is true not only of the totals, but for most of the individual cities in the table. Westfield and Greenville are exceptions to the rule as in each of these cities the partial results added together give a sum equal to the total problems. The explanation of this apparent discrepancy is that many problems involved both buying and selling. Thus it happens in Terril that the sum of the four right-hand columns exceeds the total problems for Terril. In other instances where the sum of the four right-hand columns is less than the total problems, it means that items were missed in scoring. This was unavoidable under the circumstances. It is quite possible that most

of the results except the total of persons and total of problems are slightly below what they should be, but the error is believed to be uniformly distributed, so that the proportions are correct.

An analysis was made of 1,000 unselected problems involving money, but not involving buying or selling (column 4, Table IV). It seems unnecessary to make a complete table of the results. The largest single item related to labor and wages. Out of the 1,000 problems, 451 or 45 per cent related to this topic. Interest was the topic occurring next in frequency, and equalled 11 per cent of all. Rent occurred in 6 per cent of the problems, and insurance in 4 per cent. These four items, therefore, (1) labor and wages, (2) interest, (3) rent, and (4) insurance, cover two-thirds of the topics in problems involving money, but not involving buying or selling. Other items of considerable importance were builders' estimates, banking, savings, simple accounts, expenses, discount, freight, taxes, real estate, profits, traveling expenses, and express,—although the list could be extended to 100 or more items.

Problems involving no money are equally widely distributed (column 5, Table IV). The largest single item related to time or hours of labor. This item alone was involved in 20 per cent of the problems under this caption. Problems relating to measurement of the capacity of cribs, bins, cisterns, tanks, etc., occurred in 12 per cent of the cases. Estimates of building materials occurred in 10 per cent of the cases. Other items of importance under this caption related to corn, practical measurements, weight, distance, papering, carpeting, area, milk, gasoline, checking goods, excavations, drug mixtures, etc. The complete list is quite extended, involving a long list of the common articles which are dealt with by people in general.

Table V shows for the four selected occupations, housekeepers, farmers, mechanics, merchants, that the sum of the buying and selling problems nearly equals the total of all problems.

TABLE V
BUYING AND SELLING

Occupation	Problems	Buying	Selling
All occupations.....	14,583	9,804	1,500
Housekeepers.....	7,345	5,653	299
Farmers.....	1,077	504	353
Mechanics.....	330	151	16
Merchants.....	550	316	131

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Table VI summarizes the results secured by scoring United States money throughout the entire study on the basis of the number of places involved. The problems involving United States money of over four places were not redistributed. It is probable that the form of redistribution would be similar to that in addition. (See page 42.) The close correspondence of the table throughout to all of the distributions in the fundamental processes, indicates that United States money was involved in most of the problems occurring under these processes.

TABLE VI
OCCURRENCE OF UNITED STATES MONEY

	1 P	2 P	3 P	4 P	Over 4 P	Totals
All occupations.....	270	6,786	4,302	1,513	460	13,331
Housekeepers.....	177	4,122	2,090	446	38	6,763
Farmers.....	11	476	283	132	63	963
Mechanics.....	5	114	90	40	9	266
Merchants.....	9	246	243	97	28	617

The above tables and explanations point decidedly to the conclusion that arithmetic is used by most people only when something is bought or sold, or when it is necessary to measure or determine a matter connected directly with business. The figuring involved is simple and is seldom voluntarily extended beyond what is necessary to secure the result required at the moment.

VI

TOPICS, OR THE SUBJECT MATTER OF ARITHMETIC

The instructions for scoring the topics were very simple. It soon became apparent that practically every problem involved buying or selling. The simple direction, therefore, to note the articles bought or sold gave a list of topics that was nearly complete. Table VII gives the complete list of topics involved in the study, and the number of each for all occupations and for the four selected occupations, housekeepers, farmers, mechanics and merchants. The entire list consists of 96 topics, with a total score of 14,288. They are listed in alphabetical order. The effort was made to avoid general classifications. It is an easy matter for anyone to combine different items under general heads. For instance, it is apparent that the various topics relating to food are of large importance. They include at least the following, taken direct from Table VII: Butter, 394; eggs, 462; flour, 117; food, 148; fruit, 334; garden truck, 63; groceries, 3,398; lunches, 6; meat, 663; milk, 736; pastry, 36; potatoes, 203. These topics relating to food total 6,560, or 45.90 per cent of the total of all topics.

TABLE VII
TOPICS, OR SUBJECT MATTER OF THE PROBLEMS
FREQUENCY OF OCCURRENCE
(For explanation, see text)

List (Alphabetical)	All Occu- pations	House- keepers	Farmers	Me- chanics	Mer- chants
1 Amusements.....	66	47	3	1	
2 Auction Sales.....	2				
3 Autos and Supplies.....	46	8		4	11
4 Board and Lodging.....	10		1		
5 Books.....	88	47	4	2	
6 Boxes.....	5	2			
7 Butter.....	394	294	11	8	9
8 Carfare.....	109	59	5	4	1
9 Cattle.....	102	3	60	1	
10 Cement.....	27	3	2	1	
11 Church Dues.....	9	7			1
12 Clothing.....	430	226	28	5	12

TABLE VII—(Continued)

List (Alphabetical)	All Occu- pations	House- keepers	Farmers	Me- chanics	Mer- chants
13 Coal.....	122	40	16	2	3
14 Construction.....	17	4			1
15 Corn.....	123	41	46	7	1
16 Debts.....	25	18			
17 Dental Work.....	2	1			
18 Dishes.....	8	3			1
19 Drugs.....	63	19	2		4
20 Dry Goods.....	1,195	943	16	22	49
21 Eggs.....	462	308	16	4	13
22 Electricity.....	41	23			
23 Farm Products, other.....	124	83	31		1
24 Feed.....	175	27	41	5	3
25 Fencing.....	12	1	2		
26 Fines.....	1				
27 Flour.....	117	69	8		9
28 Food.....	148	109	4	3	
29 Freight.....	16	3	1		
30 Fruit.....	334	278	9		6
31 Fuel.....	382	83	24	27	18
32 Furniture.....	40	12	3	2	5
33 Garden Truck.....	63	35	9		1
34 Glassware.....	18	13		1	
35 Grain.....	43		22		1
36 Groceries.....	3,398	2,419	104	40	117
37 Handwork.....	5	5			
38 Hardware.....	207	30	22	7	14
39 Hay.....	66	3	24	2	2
40 Hauling.....	6				
41 Hides and Leather.....	42	1	8	1	
42 Hogs.....	150	8	98		1
43 Horses.....	47	1	19		
44 Housefurnishings.....	67	30	1	2	2
45 Ice.....	26	18			
46 Implements and Machinery.....	42	2	11		2
47 Iron and Steel.....	13		1	1	
48 Jewelry.....	3	1			
49 Labor and Wages.....	743	166	44	43	19
50 Laundry.....	27	24	1		2
51 Light.....	38	8	1	7	3
52 Lodge Dues.....	11	4			
53 Lumber.....	105	4	11	1	2
54 Lunches.....	6	5			
55 Making Change.....	712	495	13	11	30
56 Meat.....	663	501	11	8	5
57 Medical aid.....	13	6		1	
58 Merchandise.....	9				2
59 Milk.....	736	545	20	12	12
60 Millinery.....	4	4			
61 Miscellaneous (Xmas.).....	834	369	36	33	26
62 Music.....	38	28			4
63 Oats.....	17		10		1
64 Oil.....	65	13	14	2	1
65 Paint.....	39	7		2	1
66 Paper.....	167	77	2	10	8
67 Pastry.....	36	36			

TABLE VII—(Concluded)

List (Alphabetical)	All Occu- pations	House- keepers	Farmers	Me- chanics	Mer- chants
68 Plants and Flowers.....	31	24	2		
69 Plumbing.....	2	2			
70 Potatoes.....	203	126	1	3	5
71 Poultry.....	236	110	51	3	9
72 Printing.....	6				
73 Real Estate.....	124	8	31	4	5
74 Recipes.....	22	18			
75 Rent.....	122	49	4	8	3
76 Repairs.....	15		2	1	
77 Rock.....	3		1		
78 Roofing.....	7	1			
79 Rugs.....	5	5			
80 Savings and Expenses.....	13				
81 Seeds.....	19	15	1		
82 Sheep.....	6		3		
83 Shoes.....	89	61	6		2
84 Soap.....	8				
85 Stamps and P. O. Matter...	66	35	3	1	2
86 Stationery.....	29	10	2		
87 Telephone.....	20	13	1	1	
88 Tents.....	1		1		
89 Tile and Brick.....	18	2	2	1	1
90 Tobacco.....	1				
91 Water.....	17	6	2		
92 Weight.....	41		1		
93 Wheat.....	22	6	7	1	
94 Wool.....	1		1		
	14,288	8,120	937	305	421

In a similar manner it is possible to bring together the topics relating to clothing. These topics in the table would be: Clothing, 430; dry goods, 1,195; merchandise, 9; millinery, 4; miscellaneous, 834; shoes, 89; giving a total of 2,561, or 17.92 per cent of the total of all topics. In this list "miscellaneous" could not all be counted as clothing, but a considerable part of it should be so counted.

It is also possible to combine in this way the various topics connected with farm products. They are listed separately under the heads of corn, grain, feed, farm products, hay, oats, wheat, hogs, horses, hides and leather, poultry, and sheep. These topics total 1,051, or 7.35 per cent of the total of all topics. These various items relating to farm products show some overlapping. Grain is so classified when it is a combination of several grains in the same problem. Feed usually relates to hay or grain bought by the farmer for feeding purposes, while the topic, "farm

products," is usually a combination of various items in a single problem. It is seen, therefore, that some general terms are used; but the details as given are much more definite than if all of the articles had been classified under the single item, "farm products," or even under two general heads, "farm crops" and "farm animals."

There is apparent overlapping in listing fuel, electricity, and light as separate topics. These four topics together total 583, or 4.08 per cent of the total of all topics. It was not possible always to tell whether electricity was being used for lighting or heating; the same was true of gas. Sometimes different topics were involved in the same problem, so that "fuel" became the most convenient term. Thus each of the four topics here listed appears to justify itself.

Since the topics are listed in such detail, it seems unnecessary to enter into an explanation of each one. The fact that so many tallies were recorded under the topic "miscellaneous" was due to the Christmas shopping as explained elsewhere (page 20). Even with the list of topics so extended, it is astonishing how large a percentage of the total is included in a very few topics. For all occupations, the ten topics with the largest scores, and the number under each, are as follows: Groceries, 3,398 (nearly 23.77 per cent of all); dry goods, 1,195; labor, 743; milk, 736; making change, 712; meat, 663; eggs, 462; clothing, 430; butter, 394; fuel, 382; total, 9,115, or 63.78 per cent of the total of all topics.

The topics vary somewhat in importance with the different occupations, but in all occupations may be noted the importance of groceries, dry goods and clothing. The ten topics scoring largest for housekeepers are: Groceries, 2,419 (29.79 per cent of all); dry goods, 943; milk, 545; meat, 501; making change, 495; eggs, 308; butter, 294; fruit, 278; clothing, 226; labor, 166; total, 6,175. Since the total of all topics for housekeepers is only 8,119, these ten items amount to 76.04 per cent of all topics for housekeepers.

The ten topics scoring largest for farmers are: Groceries, 104 (11.09 per cent of all); hogs, 98; cattle, 60; poultry, 51; corn, 46; labor, 44; feed, 41; real estate, 31; other farm products, 31; clothing, 28; total, 525. Since the total of all topics for

farmers is 937, these ten topics amount to 56.03 per cent of all topics for farmers.

The ten topics scoring largest for mechanics are: Labor, 43 (14.09 per cent of all); groceries, 40; fuel, 27; dry goods, 22; milk, 12; making change, 11; paper, 10; butter, 8; rent, 8; meat, 8; total, 189. Since the total number of topics scored for mechanics is 305, these ten amount to 63.98 per cent of all topics for mechanics.

The ten topics scoring largest for merchants are: Groceries, 117 (27.78 per cent of all); dry goods, 49; making change, 30; labor, 19; fuel, 18; hardware, 14; eggs, 13; clothing, 12; milk, 12; butter, 9; total, 293. Since the total of all topics for merchants is 421, these ten amount to 69.59 per cent of all topics for merchants.

It seems unnecessary to show detail of topics for each of the 155 occupations. The four selected occupations are, on the whole, quite representative. There are only a few topics in the entire list which do not appear under one of the four selected occupations. Topic 2 is an illustration. There were two problems reported by an auctioneer which related to his fees for auction sales. There was no other good way to classify them, and so the topic "auction sales" was added to the list. In other cases the list was extended when necessary to afford a proper classification, even at the risk of too much detail. The list is believed to be representative of the articles entering into business transactions in rural and urban districts in the Middle West.

VII

PROCESSES

What processes are involved in the figuring done by mature people? The proper answer to this question should in a large measure solve the problem set for solution in Section I. The other preceding sections contribute material that is essential in order that the study may have unity and completeness, but in some respects they provide the setting and necessary background for Section I and the present section. The controversy in arithmetic has resolved itself around the question of processes. What processes shall be included, what omitted? With regard to any particular process the question is coming more and more to be: Are the business demands of the community such as to require that this process be taught in the schools? The work involved in this section is so important that it will be discussed under three headings, dealing in turn with (1) the complete distribution of the processes involved, (2) the four fundamental processes and fractions in greater detail, and (3) the processes which do not appear in the 14,583 problems and the significance of this non-appearance.

COMPLETE LIST OF PROCESSES

The quickest view of the arithmetical processes involved in this study may be secured from Table VIII. This table shows the complete list of processes appearing in the 14,583 problems reported by 4,068 people of 155 various occupations, during the period of two weeks. There are 43 such processes, most of them represented in the problems of each of the four selected occupations shown also in Table VIII.

The list of processes was not determined without difficulty. The distinction between a process and a topic is not always clearly marked. This will be apparent to any one who attempts

TABLE VIII

PROCESSES, AND THEIR FREQUENCIES, FOR ALL OCCUPATIONS AND FOUR
SELECTED OCCUPATIONS

Process	All occu- pations	House- keepers	Far- mers	Me- chanics	Mer- chants
1 Multiplication.....	6,974	2,940	820	171	373
2 Addition.....	4,416	2,792	203	75	192
3 Subtraction.....	2,833	1,660	113	73	153
4 Division.....	2,437	972	161	65	134
5 Fractions.....	1,974	904	126	58	94
6 Accounts*.....	1,212	699	52	5	41
7 Percentage.....	417	120	18	7	27
8 Profit and loss.....	169	49	5	5	19
9 Interest.....	144	23	15	2	6
10 Fractions, multiplication of.....	130	67			
11 Discount.....	124	32	9	4	16
12 Square measure.....	124	26	7	2	4
13 Time measure.....	111	69	3	1	
14 Liquid measure.....	96	65	7		2
15 Cubic measure.....	78	5	18	5	
16 Insurance.....	78	16		1	1
17 Banking.....	64	16	2	1	5
18 Cancellation.....	62	37	4	2	1
19 Dry measure.....	57	37	1		6
20 Linear measure.....	52	10	3	1	2
21 Measuring.....	51	19	1	1	
22 Fractions, division of.....	49	29	1		1
23 Taxes.....	36	9	1	2	1
24 Avoirdupois weight.....	35	10	2	3	2
25 Carpeting.....	32	19			3
26 Circular measure.....	25	3	1		
27 Plastering.....	23				
28 Papering.....	17	10			
29 Investments.....	12				
30 Mensuration.....	12			1	1
31 Proportion*.....	10	7			
32 Fractions, addition of.....	8	5			
33 Receipts.....	8	4			
34 Decimals.....	7	1		1	
35 Commission.....	5		1		
36 Apothecaries' weight.....	4				
37 Counting.....	4				
38 Square root.....	3	1			
39 Lathing.....	1				1
40 Mortgages.....	1				
41 Partial payments.....	1				
42 Partnership.....	1				
43 Troy weight*.....	1				
Totals.....	21,898	10,656	1,574	486	1,085

* Not to be fully credited See discussion in text.

to separate the following list into processes and topics: Receipts, rent, taxes, debts, loans, insurance, making change, banking, savings. After noting the plan of a considerable number of

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texts in arithmetic, the list was arbitrarily determined, and then added to as new situations arose in scoring the problems.

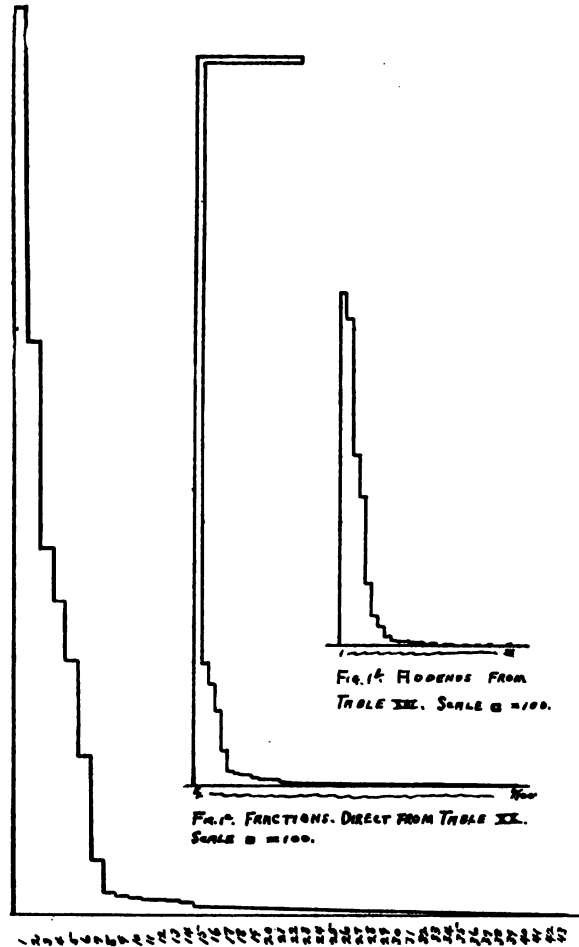


FIG. 1. Processes, frequency of, shown graphically. The numbers correspond to the processes as numbered in Table VIII.

Table VIII will justify a close study. One is impressed with the relative importance of a few processes as indicated by the number of problems reported under them. Multiplication alone includes 31.85 per cent of all the processes; addition includes

20.12 per cent; subtraction, 12.93 per cent; division, 11.12 per cent; fractions, 9.01 per cent; accounts, 5.53 per cent. The first six processes alone account for 19,846 of the processes, or 90.63 per cent of all of them. The next most important process is percentage, which, however, involves less than 2 per cent of the problems. No other process involves as many as 1 per cent. The relative frequency of the processes is shown graphically in Fig. I.

The relative frequency of the processes in each of the four selected occupations follows to a remarkable extent the order of frequency of processes for all occupations. Instances in which the order for particular occupations is not the same are time and liquid measure for housekeepers, cubic measure for farmers, discount for merchants. These variations are easily understood. The housewife is dealing more in quarts and gallons than she is in interest, discount, or square measure. The farmer, on the other hand, has much use for the measurement of capacity of cribs, bins, tanks, etc. Evidently much of this was scored under cubic measure. The merchant's use of discount is evident.

It may be assumed that the processes which occur with considerable frequency need little explanation. In fact, many of the processes which do not occur often are quite common, and need no particular explanation. Such, for instance, are carpeting, plastering, papering, addition of fractions, receipts, and counting. It seems worth while, however, to examine in detail some of the processes which occur but few times, both because of their infrequency, and because the question of omitting them entirely has been seriously considered by school men. The list selected for detailed discussion includes proportion, decimals, apothecaries' weight, square root, partial payments, partnership, and troy weight.

Proportion. While ten problems are scored as "proportion," the author has made note that four of these, while possible, are not probable, and that the other six would never be solved by proportion. The following are illustrations of the "possible, but not probable" problems:

"If 1,000 milk caps cost \$2.85, what will 144 cost?"

"If white loaf flour costs \$4.15 for 48 lbs., what will 100 lbs. cost?"

"If I bought 3 pipes for \$3.75, and needed 10 more of the same kind, how much will the entire 13 pipes cost?"

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"If I raised 35 chickens and they eat 1 box of oatmeal costing 30c a box in 2 days, how much will it cost to feed 50 chickens for 1 week?"

It is doubtful if anyone would solve the first of these problems by proportion. The natural thing to do would be to divide 285 by 1,000, and then multiply by 144. This could be done by cancellation, or simply by changing the decimal point three places, and then multiplying by 144. A similar analysis of the other three problems will make it evident that proportion is not necessary, and in all probability would not be used in solving any of the problems. The last problem could be solved by proportion, but it is much simpler if handled by cancellation.

The following are illustrations of the other six problems which would never be solved by proportion:

"If 6 bunches of radishes cost 25c, what will 2 bunches cost?"

"If 5 yds. of cloth cost \$2, what will 3 yds. cost?"

"If \$12 will buy $1\frac{3}{4}$ tons of hay, what is the price per ton?"

"If I buy 3 yds. of linen at 60c a yd., how much will $3\frac{2}{3}$ yds. cost?"

The first of these problems would be solved by simply taking $\frac{1}{3}$ of 25; the second by taking $\frac{3}{5}$ of \$2, and the third by dividing 12 by $1\frac{3}{4}$, or by $\frac{7}{4}$. The process would then be to invert and multiply. The fourth problem involves multiplication, the multiplier being a mixed number. It is safe to say that no one would ever use proportion in solving any of these problems. However, they were scored as "proportion" by help which was considered competent, and for that reason they are reported in the table. It would seem more nearly correct to omit proportion from the table.

Decimals. The direction on this process was to score *only decimals other than United States money*. The seven decimals reported involve, four of them, buying gasoline at 15.9, 19.9, 21.7, 22.5 cents, respectively; one, the distance (.008 in.) traveled by a drill press per revolution; one, finding the circumference of a tent, thus involving either 3.1416 or $3\frac{1}{7}$ in the solution; and the other one is a druggist's query on the number of cubic feet of oxygen in a room, the per cent of oxygen in the air by volume being 20.94 per cent. The seven decimals indicated above are the only ones reported by the scorers in the entire list of 14,583 problems. The use of the decimal of a cent in figuring the price of gasoline is to be commended, but is really

United States money. Aside from United States money, therefore, it is doubtful if the problems of this study indicate that decimals as a separate topic should be taught to elementary school children. For all practical purposes $3\frac{1}{7}$ will answer quite as well as 3.1416 in finding the circumference. The problems with reference to the drill press and the volume of oxygen in the room, should be undertaken only in connection with the situations that would make the meaning of these problems significant.

Apothecaries' Weight. The four problems under apothecaries' weight are all reported by physicians. They are not appropriate subject-matter for grade work. The following is an illustrative problem:

"Wishing to write a prescription containing 2 grs. potassium iodide and 10 grs. soda silicate to a dose, how much of each drug in a six ounce solution should this prescription call for considering a teaspoonful as a dose?"

Square Root. The three problems in square root involve, (a) the length of studding when the width of the barn and the rise are given; (b) the number of acres in a triangular field, the 3 sides being given; and (c) the length of a ladder required to reach the top of a 75 ft. wall if the bottom of the ladder is placed 50 ft. away from the wall. The first of these problems is a very good one indeed, although it would doubtless be more valuable to the child if he were taught to use centimeter paper, or a carpenter's square, instead of square root, in finding the answer. The third problem, reported by a physician, was evidently made up for the occasion, as no one would be likely to place the foot of a ladder so far away from a wall no higher than the one indicated.

Partial Payments. The following is the single problem in partial payments reported in this study:

"If a man purchased a farm of 240 acres on the basis of March 1, 1917 settlement, and paid a net price of \$175 per acre for the farm, and under date of August 15, 1916 he gave three Time Deposit drafts for \$5,000, each bearing date of March 1, 1916 with interest at 4%, how much would be due the grantee on March 1, 1917?"

Any bright eighth grade pupil who has been led to understand the situation involved in this problem, and who has mastered simple interest, will quite surely be able to solve the problem

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without particular difficulty. The conclusion from the data of this study is, necessarily, that partial payments may be omitted from the work of the elementary grades without material loss.

Partnership. The following is the single problem in partnership reported in this study:

"Three men bought a section of land at \$26 an acre. A bought $\frac{2}{9}$, B $\frac{1}{3}$, and C $\frac{4}{9}$. A paid \$3,000 towards the purchase price, B paid \$3,000, and C the balance. They sold the land for \$32 an acre, and C collected the money. How much would he owe A and B to satisfy the interests of each?"

The details of this transaction were handled by the real estate agent, and would probably be so handled in almost any instance. A bright eighth grade pupil would doubtless solve this problem correctly, in case the situation had been fully developed, on the basis of previous work in the fundamentals and fractions. At any rate there does not seem to be a sufficient reason, judging from this study, for teaching partnership as a separate topic to elementary pupils; the occurrence of partnership problems in real life is too infrequent, and the simple partnership problems which do occur will doubtless be solved just as well by pupils who have not been taught theoretically the process of partnership.

Troy Weight. The following is the single problem in troy weight reported in this study:

"Convert 1 T. 1,575 lbs. avoirdupois, into Troy pounds, ounces, drachms, scruples and grains."

This problem was reported by a druggist; its mixed character causes one to view it with suspicion. If the druggist meant apothecaries' instead of Troy, it is quite unlikely that he would have on hand at one time so large an amount of a single drug. Even if it is a real problem, such problems occur very seldom, and their mastery can be left to the special trades needing them. They should not be included in the work for elementary pupils.

The relative attention which the schools should give to other processes after the first seven of Table VIII should be considered with care. Even if plastering, papering, and commission appeared in common usage as frequently as taxes, insurance, and investments, it is doubtful if the same attention should be given to them in the schools. People in general do not find it necessary to figure plastering and papering, as it is done almost

entirely by special trades, frequently by the use of tables. While the figuring done by people in general on taxes, insurance, and investments may not be much greater than that on plastering and papering, the informational value of the processes is very much greater. Since the first seven processes in Table VIII cover 92 per cent of the figuring done by common people, it must be apparent that the attention to be given to processes beyond these will be determined more and more by their informational value and their appearance in a fully developed motivated situation.

The list of processes as it appears shows some overlapping, which, if avoided, would further reduce the number of processes. For instance, fractions is listed as a process, along with addition of fractions, multiplication of fractions, and division of fractions. The score under fractions was secured by scoring every fraction appearing in the study, and is the same in Table VIII as the total of all fractions appearing in Table XX. A score under one of the other processes for fractions, as addition of fractions, was made only when that process stood out prominently. True, all fractions had to be handled, and the processes should really equal all fractions, or nearly so. But many of the processes in fractions were so simple, merely involving taking one half of a number (or dividing the number by two to get one half of it), that the score was entered under the fraction to show its appearance in the study, without making a separate score for a process in fractions. It was for this reason that it was decided to enter "Fractions" as a process in Table VIII, with a frequency equal to the total of all fractions as it appears in Table XX.

The processes, measuring, mensuration, linear measure, square measure, and cubic measure (processes 21, 30, 20, 12 and 15 of Table VIII) are not mutually exclusive, but the effort was made to handle them in such a manner as to avoid overlapping. The term measuring covers measuring a room for paper, a floor for carpet, a table for a table cover, and similar cases where the person making the measurements did not find it necessary to do the required computing. Mensuration covers such problems as finding the circumference of a tent from the diameter, and the problems scored above under square root. Problems that

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could be properly scored under linear, square, or cubic measure, were so scored.

FUNDAMENTAL PROCESSES AND FRACTIONS

The weight of the four fundamental processes as shown in Table VIII should be further increased by adding to them the scores for accounts. Accounts involve chiefly addition, some multiplication, and occasionally subtraction. It is true that the fundamental processes are involved in all other processes, but a detailed examination of accounts as they appear in this study convinces the author that this process is an exception, and its score should properly be added to the score for the fundamentals. For this reason accounts is starred in Table VIII.

The fundamental processes were scored so as to show the degree of difficulty of the problems. The results for addition are summarized in Table IX. The same data are reduced to a per cent basis in Table X, in order to facilitate comparisons among the fundamental processes. Table IX is easily understood. The total addition problems for all occupations is 4,416. This is the same figure as the one for the process of addition in Table VIII. Of these 4,416 addition problems, 79 were one-place

TABLE IX

ADDITION

NUMBER OF PROBLEMS FOR ALL OCCUPATIONS AND FOR FOUR SELECTED OCCUPATIONS, DISTRIBUTED ON THE BASIS OF THE LARGEST NUMBER OF PLACES IN THE LARGEST ADDEND

	1 P	2 P	3 P	4 P	5 P	6 P	Total
All Occupations.....	79	2,143	1,655	467	66	6	4,416
Housekeepers.....	38	1,643	962	143	6		2,792
Farmers.....	4	49	94	47	7	2	203
Mechanics.....	2	26	28	16	3		75
Merchants.....	6	53	99	23	10	1	192

TABLE X

ADDITION

PERCENTAGE OF PROBLEMS OF EACH DEGREE OF DIFFICULTY FOR ALL OCCUPATIONS AND FOR FOUR SELECTED OCCUPATIONS

	1 P	2 P	3 P	4 P	5 P	6 P	Total
All Occupations.....	1.8	48.5	37.5	10.6	1.5	.1	100
Housekeepers.....	1.4	58.8	34.5	5.1	.2		100
Farmers.....	2.0	24.1	46.3	23.1	3.5	1.0	100
Mechanics.....	2.7	34.7	37.3	21.3	4.0		100
Merchants.....	3.1	27.6	51.6	12.0	5.2	.5	100

(i. e., involved only addends less than 10), 2,143 were two-place, 1,655 were three-place, 467 were four-place, 66 were five-place, and 6 were six-place. The data for the four selected occupations are similarly distributed. A problem was scored on the basis of the largest addend. Two- and three-place problems are most numerous. Section V shows that United States money is present in almost every problem and that either buying or selling is involved. This means, therefore, that there were few transactions in which all the articles involved were less than 10 cents in value, that in the largest part of them (48.5 per cent) the most costly article was valued at over 10 cents and less than \$1.00, that values ranging from \$1.00 to \$9.99 were numerous (37.5 per cent of all), but that values over \$10.00, \$100.00, and \$1,000.00, respectively, in which cents were also involved, were increasingly rare. The occurrence of six-place addition problems is less than 2 per 1,000. There are but six of them in the entire study.

The five- and six-place addition problems were searched out and analyzed in detail. Because they were so infrequent it was considered worth while to know the situations under which they occurred. The situations under which the five-place prob-

TABLE XI

FIVE-PLACE ADDITIONS

1. Sale of farm or city property.....	15
2. Bills of merchandise wholesale (11) and bills of furniture to individuals (2).....	13
3. Contractors' bills or estimates.....	9
4. Buying or selling horses, cattle or hogs.....	8
5. Balancing bank book or making deposits.....	7
6. Sale of tractors (1), or automobiles (3).....	4
7. Sale of wheat, oats, corn, potatoes, an entire crop from a farm.....	3
8. Sale of junk, carload lots.....	2
9. Grocery bill (1), oil company invoice (1), rent on 13-apartment flat (1), total of notes (1), sale of timber (1).....	5
Total.....	66

TABLE XII

SIX-PLACE ADDITIONS

1. Sale of automobile and accessories.....	2
2. Sale of wheat crop.....	1
3. Conductor's figures on weight of freight train.....	1
4. Cost of mules, plus freight and commission, 2 car loads.....	1
5. Cost of farm, taxes and improvements.....	1
Total.....	6

lems occurred are indicated in Table XI. The same data for the six-place addition problems are given in Table XII.

It is well to note from Tables IX and X the variations among the four selected occupations. The housekeepers' addition problems are strongly two-place, with few four-place and no six-place additions. Farmers show three-place additions as most numerous, with four-place additions, almost as numerous as two-place and six-place additions equaling 1 per cent. Other variations are observable. These variations are shown graphically, for addition, in Fig. 2.

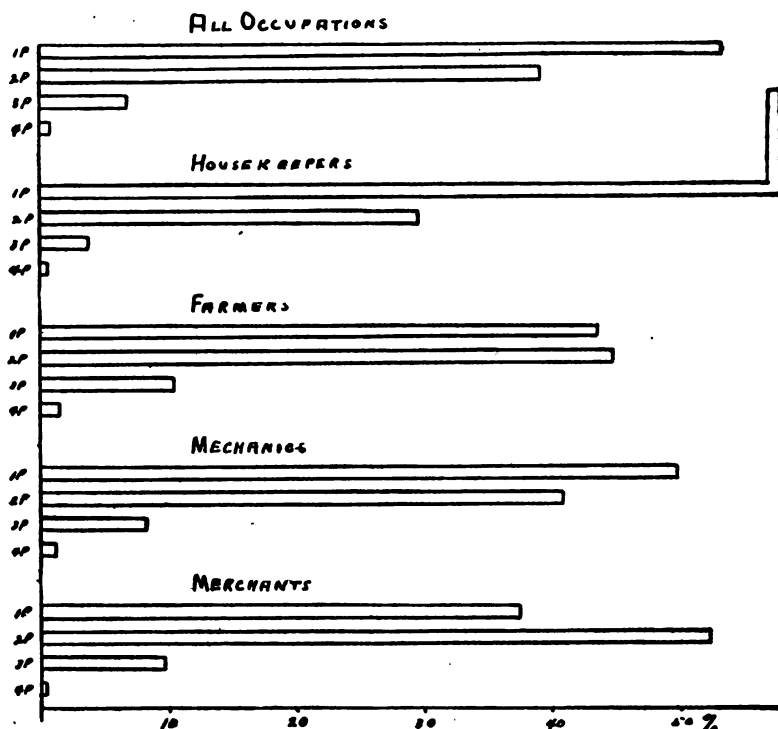


FIG. 2. Addition. Graphic representation of certain data from Tables IX and X. See text for further explanations.

The original study did not include plans for scoring the addition problems for the number of addends. This was an afterthought. The addition problems were scored for addends for two of the large cities, and the results are believed to be representative of the entire study. They are quite significant, and

are shown in Table XIII. "Two addends" receives the largest score, and this score is 31.2 per cent of the total. For addends above five, the score decreases rapidly. The one score at 19 represents a problem on balancing a bank book with 19 entries for checks written. The single scores at 21, 23, 25, and 28 represent grocery bills for a week or more each. Each item though small is listed separately; hence the large number of addends.

TABLE XIII
ADDITION—NUMBER OF ADDENDS

Addends	Sioux City	Marshalltown	Combined
2.....	178	364	542
3.....	140	368	508
4.....	102	189	291
5.....	103	81	184
6.....	51	44	95
7.....	24	18	42
8.....	16	12	28
9.....	9	3	12
10.....	6	3	9
11.....	4	1	5
12.....	4	1	5
13.....	3	0	3
14.....	2	1	3
15.....	1	0	1
16.....	3	0	3
17.....	0	0	0
18.....	1	0	1
19.....	0	1	1
20.....	0	0	0
21.....	1	0	1
22.....	0	0	0
23.....	1	0	1
24.....	0	0	0
25.....	0	1	1
26.....	0	0	0
27.....	0	0	0
28.....	1	0	1
	650	1,087	1,737

(See FIG. 1b, p. 36, for graphic representation of Table XIII.)

The typical addition problem of this study is a housekeepers problem: it involves buying groceries; it consists of two-place addition and contains two or three addends. The following are representative of the typical addition problem:

I bought 1 pk. of potatoes, 25c, 10c worth of coffee, and two 5c loaves of bread. What was my bill?

I paid \$7.50 for a sack of sugar and \$3.50 for a sack of flour. What was the amount of my bill?

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I bought 5 lbs. of butter costing 40c a lb. and 2 doz. eggs at 45c a doz. How much was my bill?

I had a dollar to buy 2 yds. of lace at 25c per yd., and 5 spools of thread at 5c a spool. How much change did I receive?

Bought a hat for \$3.00 and a coat for \$15.00. How much did I spend?

Mother went to the store and bought 1 lb. of butter at 44c, cake 25c, 1 doz. eggs 38c. She gave the grocer a \$5 bill. How much change did she receive?

The simplicity of the addition problems occurring in adult activity, as revealed by this study, is in marked contrast with the addition work appearing in many schools and arithmetic texts. Considering the infrequency with which five- and six-place additions occur in the business relations of adults, it is doubtful if the schools are justified in imposing a large number of such problems upon children. Not only should we question our school-room practices and re-examine our text-books, but we should hesitate to class as "standard" an addition test which does not conform measurably to the addition needs of adults.

The limits of this study will not permit the same detailed analysis of the three other fundamental processes. However, tables are shown for each process similar to Tables IX and X for addition. Tables XIV and XV show a distribution of subtraction problems according to the number of places involved. It

TABLE XIV

SUBTRACTION

NUMBER OF PROBLEMS FOR ALL OCCUPATIONS AND FOR FOUR SELECTED OCCUPATIONS, DISTRIBUTED ON THE BASIS OF THE NUMBER OF PLACES INVOLVED IN THE MINUEND

	1 P	2 P	3 P	4 P	5 P	6 P	Total
All Occupations.....	222	930	1,101	504	69	7	2,833
Housekeepers.....	58	609	706	273	12	2	1,660
Farmers.....	3	29	37	31	11	2	113
Mechanics.....	2	26	25	17	3		73
Merchants.....	1	38	67	41	5	1	153

TABLE XV

SUBTRACTION

PERCENTAGE OF PROBLEMS OF EACH DEGREE OF DIFFICULTY FOR ALL OCCUPATIONS AND FOR FOUR SELECTED OCCUPATIONS

	1 P	2 P	3 P	4 P	5 P	6 P	Total
All Occupations.....	7.8	32.8	38.9	17.8	2.4	.3	100
Housekeepers.....	3.5	36.7	42.5	16.4	.7	.2	100
Farmers.....	2.7	25.7	32.7	27.4	9.7	1.8	100
Mechanics.....	2.7	35.6	34.3	23.3	4.1		100
Merchants.....	.65	24.8	43.8	26.8	3.3	.65	100

will be observed that subtraction follows addition in its main features; the chief difference is that the subtraction problems tend on the whole to involve more places than addition. This results from the fact that many of the subtraction problems occur only after addition has taken place. The individual desires to know, e.g. after buying a number of articles, how much change she will receive in case she gives the clerk a two-dollar bill. The bulk of the problems, however, come under two-place and three-place subtraction, and very few problems occur with more than four places.

An analysis of the 6,974 multiplication problems is shown in Tables XVI and XVII. The largest single score for multiplication problems occurs under one-place for all occupations, and also for housekeepers and mechanics. Farmers and merchants show the largest score under two-place. The factor determining the score is the multiplier. This means that the housekeeper and mechanic usually buy in quantities less than 10. The merchant buys in quantities ranging from 10 to 99, more often than in quantities of less than 10. When the farmer buys groceries, he buys in considerable quantity. Aside from groceries, the farmer sells more often than he buys. He sells hogs more often than any other single article, and this is followed closely by cattle,

TABLE XVI

MULTIPLICATION

NUMBER OF PROBLEMS FOR ALL OCCUPATIONS AND FOR FOUR SELECTED OCCUPATIONS, DISTRIBUTED ON THE BASIS OF THE NUMBER OF PLACES IN THE MULTIPLIER

	1 P	2 P	3 P	4 P	5 P	Total
All Occupations.....	3,705	2,733	483	53		6,974
Housekeepers.....	1,942	868	117	13		2,940
Farmers.....	358	366	84	12		820
Mechanics.....	85	70	14	2		171
Merchants.....	140	195	36	2		373

TABLE XVII

MULTIPLICATION

PERCENTAGE OF PROBLEMS OF EACH DEGREE OF DIFFICULTY FOR ALL OCCUPATIONS AND FOR FOUR SELECTED OCCUPATIONS

	1 P	2 P	3 P	4 P	5 P	Total
All Occupations.....	53.1	39.2	6.9	.8		100
Housekeepers.....	66.1	29.5	3.9	.5		100
Farmers.....	43.7	44.6	10.2	1.5		100
Mechanics.....	49.7	40.9	8.2	1.2		100
Merchants.....	37.5	52.3	9.7	.5		103

grain, and poultry. The scores under multiplication indicate that the farmer sells ten or more articles at one time more often than he sells less than ten. As we go above two-place multipliers, the number of scores decreases rapidly. There are but 53 four-place multiplications in the study, and no five-place multiplications. The relative frequency of the various place multipliers is shown graphically in Fig. 3 for all occupations and for the four selected occupations.

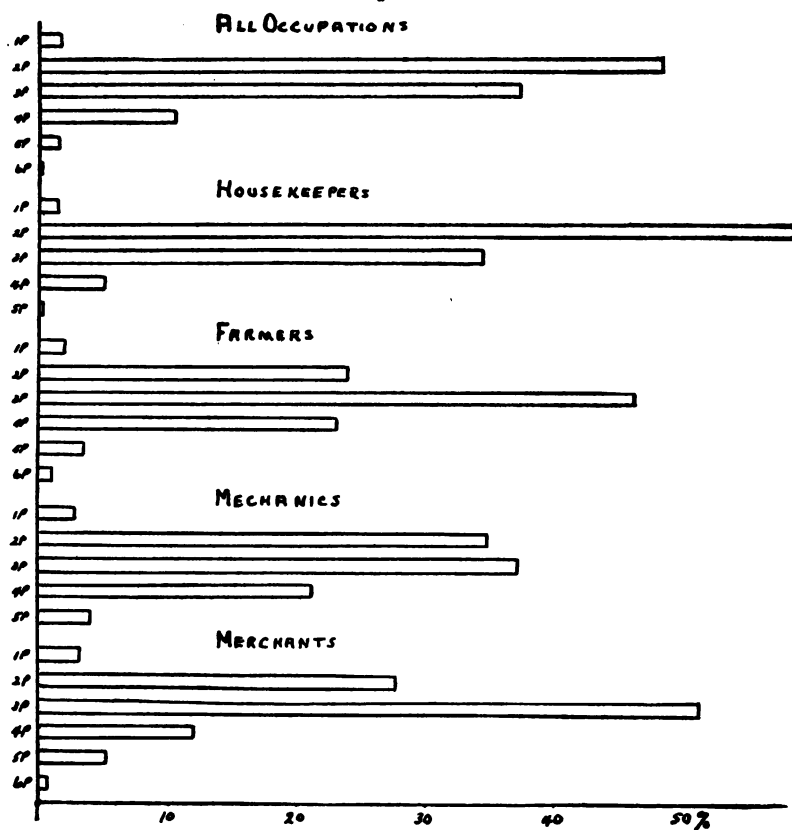


FIG. 3. Multiplication. Graphic representation of certain data from Tables XVI and XVII. See text for further explanations.

An analysis of the 2,437 division problems is shown in Tables XVIII and XIX. It is apparent that division follows along the same lines as multiplication. The scoring is based on the number of places in the divisor. The most common reason for

dividing is to find the cost of one article when the cost of several articles is given. While particular divisors were not scored, it is believed that 12 is the one divisor occurring most frequently. This is because of the practice of bartering in many articles by the dozen. The score for all occupations and for three of the selected occupations is highest under two-place division. As we go above two-place divisors the number of scores decreases, but not quite so rapidly as in multiplication. There are 102 four-place division problems and 1 five-place. The following is the single five-place division problem in the study:

A lawyer had \$500,000 when he retired at the age of 65. He spent \$18,000 a year, and it cost him \$350,547 to keep up until he died. How long did he live?

This problem may be a real one, and it doubtless is; it was reported by a lawyer. However, it is not difficult, and could really be reduced to a two-place division problem by shifting the decimal point three places. It should be remembered that there was but one such problem in the entire list of 14,583 problems involved in this study.

TABLE XVIII
DIVISION

NUMBER OF PROBLEMS FOR ALL OCCUPATIONS AND FOR FOUR SELECTED OCCUPATIONS DISTRIBUTED ON THE BASIS OF THE NUMBER OF PLACES IN THE DIVISOR

	1 P	2 P	3 P	4 P	5 P	6 P	Total
All Occupations.....	966	1,058	310	102	1		2,437
Housekeepers.....	463	433	64	12			972
Farmers.....	35	72	39	15			161
Mechanics.....	24	33	6	2			65
Merchants.....	51	61	19	3			134

TABLE XIX
DIVISION

PERCENTAGE OF PROBLEMS OF EACH DEGREE OF DIFFICULTY FOR ALL OCCUPATIONS AND FOR FOUR SELECTED OCCUPATIONS

	1 P	2 P	3 P	4 P	5 P	6 P	Total
All Occupations.....	39.6	43.4	12.8	4.1	.1		100
Housekeepers.....	47.6	44.6	6.6	1.2			100
Farmers.....	21.8	44.7	24.2	9.3			100
Mechanics.....	36.9	50.8	9.2	3.1			100
Merchants.....	38.1	45.5	14.2	2.2			100

Fractions. When this study was first started a general scheme was arranged for the scoring of fractions.* It soon became evident that the list of fractions would not be very extended, and that every fraction could be scored. A total of 1,974 fractions occurs in the entire study. Few problems contain more than a single fraction. A fraction occurs in every eighth problem, generally speaking. All fractions, together with their frequencies, are shown in Table XX, for all occupations and for the four selected occupations. This table is a fair index of the relative importance of the various fractions so far as actual business usage is concerned. The fraction $\frac{1}{2}$ makes up almost two thirds (65.3 per cent) of all. The first ten fractions total 1,881 and constitute 95.5 per cent of all. The entire list contains only 50 fractions; and of these 21 occur but a single time in the entire study. The following gives a brief explanation of the occurrence of some of the least common of the fractions:

- 6/100, size of hole to be drilled, reported by a machinist.
- 5/32, width of bolt thread, reported by a factory foreman.
- 1/32, 1/24, 1/18, involved in the division of an estate, reported by an attorney.
- 17/25, 9/15, 5/12, reported by a factory foreman in a problem involving successive lifts by a hydraulic lifting jack.
- 7/16, buying round iron, diameter 7/16, reported by a blacksmith.
- 7/12, two problems; one relating to sale of eggs, the other reported by a marker in an overall factory.
- 1/11, 4/11, relate to the cost of milk per quart and cream per pint respectively, reported by a housewife.

Most of the fractions reported are quite surely involved in real situations. The doubtful cases are the three fractions starred. It will be observed that 1/11 and 4/11 come in this class. It is not impossible, but improbable, that milk tickets would be bought in any other way than so many for a quarter or a dollar. The fractions 1/11 and 4/11 occurred in the answer, therefore, and should not have been scored. Fractions are scored only when they are involved in a process. The appearance of a fraction in the answer only, merely requires that it be read correctly.

The appearance of tenths in fractional form instead of the decimal form, even when money (mills) is involved, is a little annoying to one who prefers the decimal system. Fractions with

* See *Sixteenth Year Book of the National Society for the Study of Education*, Part I, Chap. VIII.

TABLE XX

FRACTIONS USED BY MATURE PEOPLE. TABLE OF FREQUENCIES

	List of	All Occu- pations	House- keepers	Farmers	Mechanics	Merchants
1.....	1/2	1,289	708	87	28	62
2.....	3/4	189	59	12	4	6
3.....	1/4	159	46	12	6	9
4.....	1/3	119	30	4	8	5
5.....	2/3	54	13	3	2	5
6.....	3/8	20	2	1	1	1
7.....	2/5	15	1			
8.....	4/5	13	4	1	1	1
9.....	1/8	13	1	1		1
10.....	1/5	10	2		1	
11.....	5/8	8	1	1	1	1
12.....	1/10	8	1		1	
13.....	7/10	8				
14.....	1/6	6	4			
15.....	1/12	5	1			
16.....	3/5	4	1			
17.....	7/8	4	1		1	1
18.....	2/10	4			1	
19.....	1/7	3	2		1	
20.....	4/9	3				
21.....	6/10	3				
22.....	1/9	2				
23.....	2/9	2				
24.....	3/10	2	1			1
25.....	9/10	2			1	
26.....	5/12	2	1			
27.....	7/12	2				2
28.....	1/16	2	2			
29.....	11/16	2		2		
30.....	2/6	1				
31.....	4/6	1				
32.....	6/7	1				
33.....	6/9	1				
34.....	1/11*	1	1			
35.....	4/11*	1	1			
36.....	5/11	1	1			
37.....	2/12	1				
38.....	4/12	1				
39.....	11/12	1				1
40.....	9/15	1				
41.....	5/16	1				
42.....	7/16	1				
43.....	6/17	1				
44.....	1/18	1				
45.....	1/24	1				
46.....	5/24*	1	1			
47.....	17/25	1				
48.....	1/32	1				
49.....	5/32	1				
50.....	6/100	1			1	
Totals.....		1,974	885	124	58	96

* Validity questioned. See text for explanation.

(See Fig. 1a, p. 36, for graphic representation of Table XX)

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10 as a denominator (except $1/10$, which is excluded from this particular statement) appear 19 times in this study, 6 times where money is not involved and 13 times where it is involved. The 19 instances are noted briefly herewith:

Without money,

$2/10$, sale of cream, 11 $2/10$ lbs.

$3/10$, buying coal, 4 $3/10$ tons.

$6/10$, $6/10$, time on printing job, $6/10$ hrs. and 4 $6/10$ hrs.

$7/10$, buying coal, 3 $7/10$ tons.

$9/10$, laborer spent $9/10$ of his salary.

Money involved,

$2/10$, $2/10$, $2/10$, buying gasoline.

$3/10$, buying gasoline.

$6/10$, freight rate 5 $6/10$ c per cu. ft. on stone.

$7/10$, $7/10$, $7/10$, $7/10$, $7/10$, $7/10$, $7/10$, buying gasoline.

$9/10$, buying gasoline.

Taking fractions as a whole as shown in this study, there is no escaping the conclusion that the work in fractions can be greatly simplified and still meet adequately the demands of business practice for the great mass of the population. Near the middle of an intermediate arithmetic in a three-book series that is generally looked upon as progressive, the following fractions appear: $12/21$, $36/56$, $32/45$, $54/56$, $45/48$, $38/90$, $56/61$, $39/49$, $76/90$. Certainly such a list of fractions should be carefully scrutinized before being assigned to fifth grade pupils.

PROCESSES NOT APPEARING IN THIS STUDY

The processes appearing in this study so few times as to suggest their omission from the arithmetic work of the elementary grades have been noted and discussed. They are:

1. Decimals, except in United States money.
2. Apothecaries' weight.
3. Partial payments.
4. Partnership.
5. Square root.
6. Proportion (really absent).
7. Troy weight (really absent).

Processes or details which have not appeared in the study are:

1. Greatest common divisor and least common multiple beyond the power of inspection.
2. Long, confusing problems in common fractions.

3. Complex and compound fractions.
4. Reductions in denominate numbers.
5. Table of folding paper, surveyors table, tables of foreign money.
6. Compound numbers, neither addition, subtraction, multiplication nor division.
7. Longitude and time.
8. Cases 2 and 3 in percentage.
9. Compound interest.
10. Annual interest.
11. Exchange, neither domestic nor foreign.
12. True discount.
13. Partnership with time.
14. Ratio, beyond the ability of fractions to satisfy.
15. Most of mensuration,—the trapezoid, trapezium, polygons, frustum, sphere.
16. Cube root.
17. The metric system.

It would appear to be a safe and conservative procedure to recommend for omission from the elementary work in arithmetic, the processes which do not appear at all in such an extensive study of adult usage of arithmetic as the present one. The few sentences which follow go a step further in that they state the same conclusion in positive form.

If to the four fundamentals and fractions one were to add accounts, simple denominate numbers, and percentage, little would be left for all the other processes,—so little in fact that it seems unfair to give attention to them as drill processes in the elementary schools. Some of them should receive no attention. Others should receive attention only for informational purposes or when found necessary in the development of motivated situations. Not only should certain processes be entirely omitted as drill work, but other processes should be reorganized in line with business usage. This means that situations and terms foreign to business practice are to be replaced by others more wisely selected. It means that the work in the fundamentals, fractions, simple denominate numbers and percentage is to be greatly simplified.

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The simplicity of the situation shown by this analysis of adult usage is shown in Table XXI, which is derived directly from Table VIII by bringing all references to fractions in Table VIII under one heading, by combining all applications of percentage with percentage, and by bringing all work in denominate numbers together.

TABLE XXI
THE PROCESSES AND THEIR FREQUENCIES DERIVED FROM TABLE VIII BY
CONDENSING AND SIMPLIFYING

Process	All Occu- pations	House- keepers	Farmers	Me- chanics	Mer- chants
1. Multiplication.....	6,974	2,940	820	171	373
2. Addition.....	4,416	2,792	203	75	192
3. Subtraction.....	2,833	1,660	113	73	153
4. Division.....	2,437	972	161	65	134
5. Fractions.....	2,171	1,012	127	58	95
6. Accounts.....	1,212	699	52	5	41
7. Percentage and Applications..	1,060	269	51	22	76
8. Simple Denom. Numbers..	707	273	43	13	19
9. Cancellation.....	62	37	4	2	1
10. Mensuration.....	12			1	1
11. Decimals.....	7	1		1	
12. Counting.....	4				
13. Square Root.....	3	1			
	21,898	10,656	1,574	486	1,085

VIII

CONCLUSION

It is unwise for the author of a study to attempt to apply it too widely because of a possible bias as to its value. Such application will not be attempted in detail in the present case, because the application in detail of the results of this study to schoolroom practice, courses of study, and textbooks would involve additional studies, each as extensive as the present one. To evaluate a dozen of the leading series of arithmetics in the light of this study would involve fully a year's work.* This is evident from the scoring of a single two-book series.

The study as it stands, while having some sources of error, is believed to furnish the best single basis yet available for determining the content of arithmetic as it should appear in schoolroom practice and courses of study. It is evident from this study that many of the traditional processes of arithmetic should be entirely omitted. It is no longer a matter of mere opinion. The evidence is clearly at hand. These traditional processes have been unusually difficult for children, in part because they have had no practical use and so did not connect with experience. No school superintendent can longer justify himself in imposing them upon little children. The "weight of evidence" is in favor of their elimination. Even before including these processes in the arithmetic work of the commercial course in high school, their actual business value should be established by a survey of the arithmetic of the lines of business toward which the commercial students are looking for employment.

It should be remembered that this study is based not upon child activity but upon adult activity, upon the actual arithmetic

* A hundred superintendents or research students throughout the country could do this and much more in a month's time, and the author will gladly send detailed directions for scoring arithmetic texts to any one who may apply for them. If such applicants will indicate which series of arithmetics it is proposed to score, the author will endeavor to help to avoid duplication of effort.

needs of mature people. If the arithmetic situation revealed were a very complicated one, there would be reason for rejecting it since there is such a wide difference between child interests and adult interests. But the situation revealed is a surprisingly simple one when compared with present school practice, and it is asked only that the arithmetic required of children be reduced to the level set by adult usage.

The converse of this proposition, viz., that children be taught arithmetic in such a manner that more of it shall carry over as a useful tool in adult activity, does not involve more difficult processes nor any of the traditional processes which this study indicates should be eliminated. It does require that after the useful processes are learned, or even while they are being learned, they be used in situations that are real, motivated, and made a part of the life and purposes of the children. Such work will give breadth of view, business information, and business experience to the limits of child ability. Evidence is already accumulating that such procedure will insure the carrying over of arithmetic as a useful business tool in later life, much more fully than at present.

In the simple processes which should receive extended treatment in the elementary grades (the first eight processes in Table XXI) a greater degree of accuracy than is now common should be secured. In the fundamental processes and simple fractions, letter perfect results should be attained on problems approximating in difficulty those encountered in actual business usage.

It is doubtful if arithmetic is entitled to the large time expenditure which is now allotted to it in the elementary grades. In spelling, since the work of Ayres and Jones, there is less of a "grind," a reduced time expenditure, and a better grist. So in arithmetic, if the effort is applied where it is needed, we may expect a better functional result from a decreased time expenditure.

On the negative side, this study shows that adults do not figure through complete situations, such as budgeting the family income, determining by careful estimate in advance the desirability of buying a car-load of steers and finishing them for market, or determining the relative advantages of renting or buying city property. Work of this kind would not involve more difficult arithmetical processes, but it would indicate a

more intelligent application of arithmetic to complete business situations. The entire absence of work of this character may indicate a need which the schools have not formerly met, and which can be adequately met only by definitely organizing large motivated business situations for public school work. If the present time expenditure in arithmetic is to be maintained, certainly an increasing proportion of the time should be given to work of this character as we go from intermediate to upper grades.

A METHOD OF STUDY

One result of this study which should be permanent is that it provides a method for determining the proper content of the arithmetic course in any particular community and a method of checking tests in arithmetic in the light of the community's needs. The early realization on the part of the author and his advisors that the study should be of permanent value in providing a method, led to the decision that the methods of gathering and evaluating the data should be quite fully explained in the final report of the study (see Sections II and IV). The present study is more extensive than necessary; the problems for a single week would have shown the same distributions. For a city of 50,000, a survey for a single week on the plan of this study will give useful results. If two weeks are used in such a survey, the second week should come at a different season of the year. For small communities, the survey should be conducted for two weeks. The returns, while not large, will be in proportion to a community's activities, and will furnish valuable information on which to base further simplifications of the drill work in arithmetic as well as data for the shaping of real problems.

LIMITATIONS OF THE STUDY

The study is based upon data gathered in the Middle West. It may not apply to the peculiar marketing conditions on the east side of New York City or the stockyards district of Chicago. It will be a helpful guide for a state course of study in arithmetic in any of the states of the Middle West. It doubtless will apply in large measure to other parts of the country,—most of the North and West, and the South, except for local adaptations in

the selection of topics. It is suggestive for all parts of the country.

Throughout this study the suggested applications to school work have been to the course in arithmetic for the elementary grades. This is a safe limitation. The study shows the arithmetic needed by the masses, the 95 per cent of the population. It does not attempt to analyze the specific requirements of different business and commercial pursuits. The arithmetic needed for such work is usually learned in the business, or is taught in special courses in business colleges and commercial high schools, or in schools of technology and engineering. Such usage may form a proper basis for a considerable part of the content of the arithmetic course in the commercial high school; it certainly should not form the basis of the elementary course except as pupils are led into selected phases of business practice through motivated problems.

That arithmetic is necessary in order that people may develop ideas of magnitude and be able to comprehend number ideas as encountered in the daily papers, magazines, etc., is a common notion. Arithmetic doubtless is helpful here, but it should be remembered that the masses got along for centuries without any arithmetic, that it was not introduced into the first grammar schools of our own country, and that it was not required for college entrance until 1745 (Yale). While not denying other values,—disciplinary, cultural, development of magnitude concepts needed for general knowledge,—the author is willing to express a personal preference in favor of business utility as the best single guide for the selection of subject-matter in arithmetic for the elementary grades, although the establishment of this point is in no way necessary in order to establish the value of this study. Even those who would select subject-matter on some other basis will admit the value of knowing the facts with reference to adult usage of arithmetic. The fact that such usage is much simpler than present school practice, puts the burden of proof on those who would continue the present school practice.

It is not the purpose of the present study to determine method, but *matter*. What matter does society and business require? That is the first and great question. Readjustment of time schedules, revision of curricula, and changes in method should

follow. All of these are ineffectual if applied to the wrong subject-matter.

SOURCES OF ERROR

Possible sources of error have been suggested in connection with particular sections of the study. The following, largely a summary, are believed to be the chief sources of error:

(1) Men and women in order to be accommodating, or to satisfy their children, have invented problems for the occasion. It is believed that most of these problems have been detected and thrown out.

(2) Material has been put into problem form which ordinarily would be permitted to go without solution. This does not change the character of the results, but tends to raise the total scores throughout.

(3) Some parents did not contribute because they were busy or did not care to be bothered, or because of absence from home when children were awake. Such people are generally distributed and do not change the results except to lower the scores.

(4) Pupils have not reported accurately in all cases. This is believed to account for one or two of the odd fractions. On the whole the study bears evidence of 100 per cent honesty in the returns.

(5) The people from whom problems were gathered are on the whole too mature and too highly selected. This has been discussed. It tends to make the arithmetic reported too difficult to be representative.

(6) The addition and subtraction problems were scored too high, due to carrying ciphers when no cents were involved. This could have been corrected only by re-scoring, and involved too much effort to justify it. The error is believed to be about one problem in twenty for three-, four-, five- and six-place addition and subtraction, i.e., one problem in every twenty should be reduced two places. This estimate is based upon a careful scoring of 500 addition problems with this point alone in mind. The suggested corrections were not made in the tables.

(7) Because of the large number of factors to be kept in mind in scoring a problem, there is a small constant error due to failure to score some one of the factors in any particular problem.

The error is believed to be small and evenly distributed, so that the total scores are proportionally correct.

(8) In interpreting the tables, small differences are to be neglected. When figures run close together, a little different selection of persons for report might have changed the results even to the extent of reversing the order of some of the topics or processes. But while neglecting small differences, it should be remembered that the total situation has decided value.

(9) In connection with the average number of problems solved in two weeks, it should be noted that no particular importance attaches to this average. It is probable that arithmetic is used much less than commonly supposed, but the important consideration from the standpoint of this study is to get reports that are representative of usage. There is little doubt that, psychologically, people would tend to report the more difficult problems since such problems would be outstanding and would focus attention, while the simpler problems would be forgotten or neglected or considered too unimportant to justify report.

Taken as a whole, the errors are believed to be slight, evenly distributed, or mutually corrective. The magnitude of the study is such as to inspire confidence. Accepting the assumptions of Section I, the findings leave no doubt as to conclusions.

APPENDIX A: BIBLIOGRAPHY

The brief bibliography given herewith lists only works referred to in the study, to which an interested reader might wish to turn in order to understand the connection of passages or data used. It omits a long list of works to which the author is under obligation for suggestions and help, either directly or indirectly.

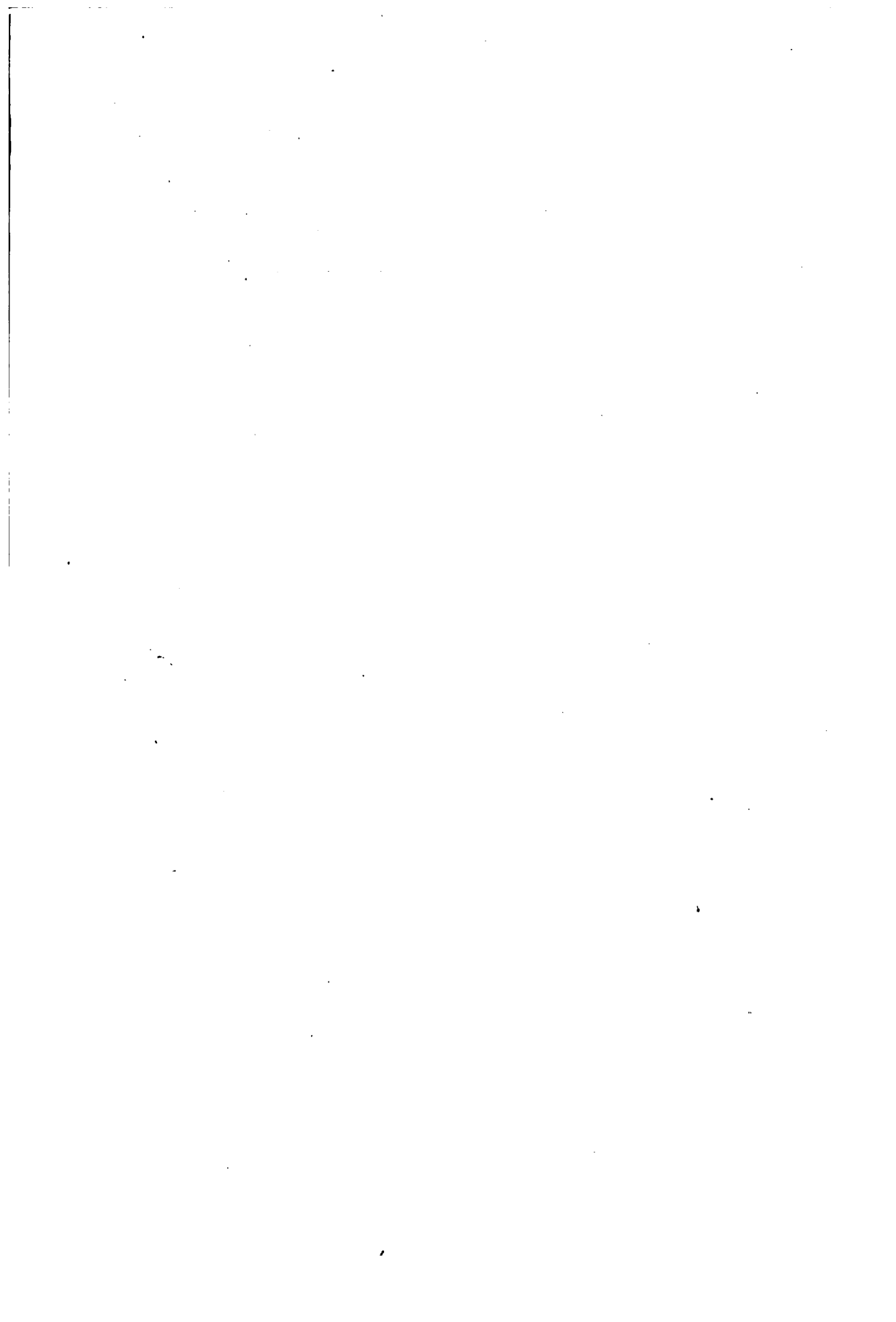
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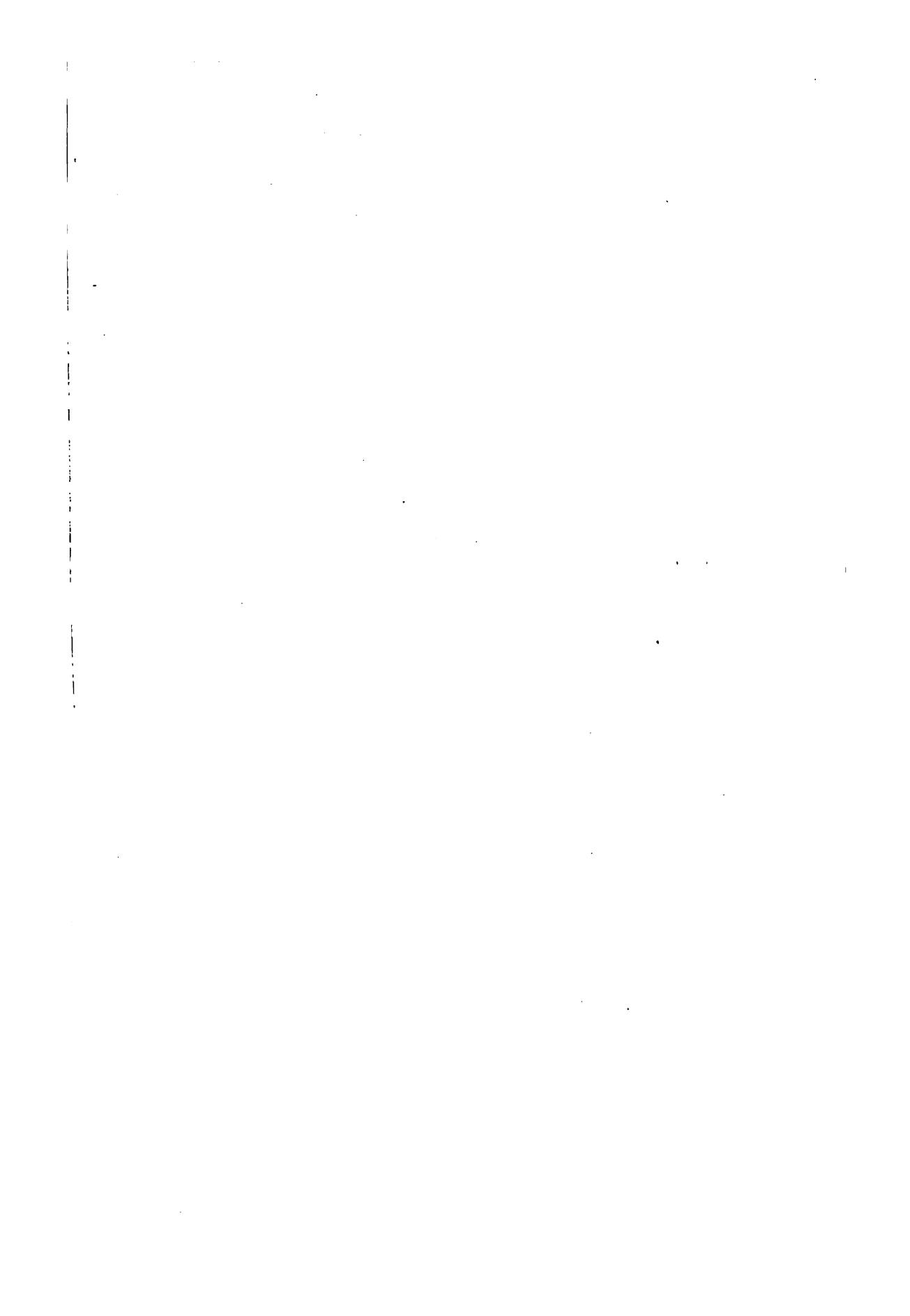
APPENDIX B

APPLYING THE METHOD IN A HIGHLY SPECIALIZED COMMUNITY

During the fall of 1917 arrangements were made with Mr. R. O. Runnels, a grade principal of Maplewood, New Jersey, to coöperate in testing the method in a small and highly specialized community. About 90 to 95 per cent of the men are commuters and work in offices in New York City (lower Manhattan). The following are the conclusions of the study:

1. The mothers report quite fully.
2. Little of the figuring of the highly specialized occupations appears in the pupils' reports. From so few reports this would be expected. But occasional specialized problems do appear, and if the number of persons involved were large there would be a fair sampling. Most of the highly specialized figuring is too difficult for pupils to take and so it comes in only when the father will take time to write it out.
3. What does come in is what is wanted, in any case, as a basis for the elementary course.
4. Mr. Runnels thinks that the highly specialized arithmetic would be too difficult in his case for the commercial course in high school, although wise selection of certain lines of the specialized work could be used in the commercial high school. For example, the figuring of an engineer on the expansion and contraction of bridge girders and allowances to make on certain temperature readings, would not be suitable, although some of the problems reported by the expert accountant would be suitable. The problems of the railway freight rate-maker would not be suitable, nor those of the actuary, but many of those of the commission merchant would be suitable for work in the commercial course in high school.
5. It appears therefore that children will report problems of the common and intermediate grades of difficulty, all that are of any use in the elementary course, and even some that are too difficult.





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